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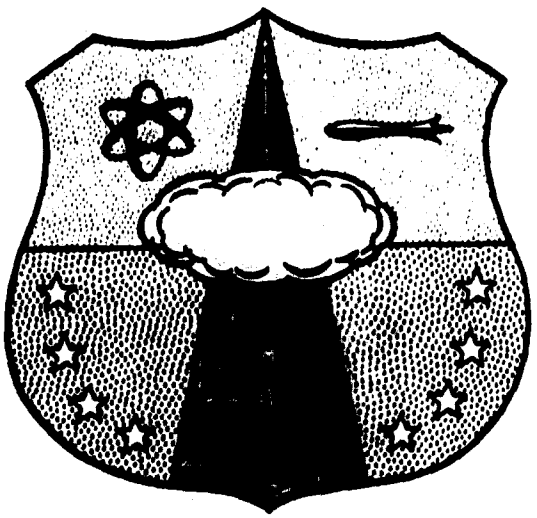

Final Report

THEORETICAL STUDY OF OPTICAL PROPERTIES

Photon Absorption Coefficients, Opacities, and Equations of State of Light Elements, Including the Effect of Lines

by

John C. Stewart Kedar D. Pyatt, Jr.

General Atomic Division
General Dynamics Corporation
San Diego, California

September 1961

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Kirtland Air Force Base
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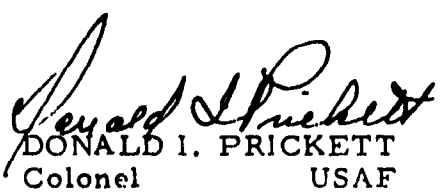

DONALD I. PRICKETT
Colonel USAF
Director, Research Directorate

ABSTRACT

Photon absorption coefficients and mean opacities have been calculated for hydrogen, beryllium, carbon, nitrogen, aluminum, and silicon over a temperature range from 1.5 to 34 ev and a density range from about 10^{-1} g/cm^3 downward. Contributions to the absorption coefficient from free-free (inverse-bremsstrahlung), bound-free (photoelectric), and bound-bound (line-absorption) processes are included, as is Compton scattering. Certain thermodynamic properties are also given. An improved recipe for pressure ionization is derived which is approximately valid at nondegenerate densities for any ratio of Debye length to ion-sphere radius. Line absorption is evaluated using recent results from pressure-broadening theory and a representation of line series which is computationally as simple as the statistical method. The results show that lines increase the Rosseland mean opacity by a factor which can be nearly ten and which is insensitive to moderate changes in line widths. The code employed generates ionic energy levels internally by isoelectronic interpolation, and is immediately applicable to any mixture of elements in which no ion has more than 14 bound electrons.

The results of the calculations of thermodynamic properties and mean opacities are given in the tables in Appendix A, and the graphs of the monochromatic absorption coefficients are given in Appendix B, which comprises Vols. II and III.

PUBLICATION REVIEW

This report has been reviewed and is approved.

John J. Dishuck

JOHN J. DISHUCK
Colonel USAF
Deputy Chief of Staff for Operations

CONTENTS

I. BASIC DEFINITIONS AND RELATIONS

When photons travel in an absorbing medium, the probability that a photon goes a small distance, dx, without interacting with the medium is $1 - dx/\Lambda$, where Λ is called the absorption mean free path. The reciprocal of Λ is called the linear absorption coefficient, cross section per unit volume, or inverse mean free path, and is conventionally denoted by μ. The ratio μ/ρ, where ρ is the mass density of the medium, is the mass absorption coefficient or cross section per unit mass, κ. It is the sum of the absorption cross sections of a representative ensemble of the atoms, ions, and molecules in the medium, divided by the sum of their masses. Generally, Λ, μ, and κ depend strongly on photon frequency and thus carry the subscript ν. Certain weighted averages of κ_ν with respect to ν are called opacities. In particular, the "Rosseland mean opacity" is defined as

$$\kappa_R \equiv \frac{\int_0^\infty \frac{dB_\nu}{dT}\, d\nu}{\int_0^\infty \frac{dB_\nu}{dT} \frac{1}{(1 - e^{-h\nu/kT})\kappa_\nu}\, d\nu} \tag{1}$$

and the "Planck mean opacity" as

$$\kappa_P \equiv \frac{\int_0^\infty B_\nu \kappa_\nu (1 - e^{-h\nu/kT})\, d\nu}{B}\,, \tag{2}$$

where

$$B_\nu = B_\nu(T) = (2h\nu^3/c^2)\,(e^{h\nu/kT} - 1)^{-1}$$

is the specific intensity (energy per unit time, area, solid angle, and frequency interval) at frequency ν of black-body radiation at tempera-

ture T, and where

$$B = \int_0^\infty B_\nu \, d\nu = \frac{\sigma T^4}{\pi} .$$

The opacities which have just been defined are relevant to radiative transfer problems only when the matter is in local thermodynamic equilibrium (LTE) at temperature T, and in the case of the Planck mean this condition is not always easy to establish. When it holds, the spontaneous emission coefficient (energy radiated per unit time, mass, solid angle, and frequency interval) is

$$j'_\nu = B_\nu \kappa_\nu (1 - e^{-h\nu/kT}) \qquad (3)$$

whether the radiation present is in equilibrium with the matter or not. If the radiating region is now assumed to be optically thin (small compared with the photon mean free path, Λ_ν) at all frequencies, every photon emitted will escape, there is no induced emission, and the total rate of energy loss per unit time and mass is just $4\pi\kappa_P B$; but this overestimates the energy-loss rate if any photons are reabsorbed, i. e., if the radiation present approaches black-body intensity at any frequencies. Accordingly, the utility of the Planck mean is restricted to situations where particle collisions are frequent enough to maintain LTE without any assistance from the radiation field.

The Rosseland mean is relevant only to an optically thick region in which a small temperature gradient exists--more precisely, in which $\Lambda_\nu |\nabla T| \ll T$ and Λ_ν is much less than the dimensions of the region, at all frequencies. Then the radiation field at any point looks nearly like the black-body radiation appropriate to the local temperature (except for a small asymmetry in angle, which drives the radiative flux), and LTE is maintained automatically, whether particle collisions or radiative processes dominate the transition rates between states. Under these circumstances, the radiative flux (net energy per unit time and area crossing a surface

normal to the temperature gradient) is

$$\vec{F} = -4\pi \frac{\Lambda_R}{3} \nabla B \,, \tag{4}$$

where $\Lambda_R = 1/\rho\kappa_R$. Derivations of the above relations are given, for example, by Chandrasekhar.[1]

There is a large class of radiative transfer problems involving regions which are optically thick at some frequencies and thin at others, so that even if LTE prevails, the Rosseland and Planck mean opacities are not applicable. An example is the atmosphere of almost any star. In such problems it is generally necessary to proceed iteratively, treating each frequency separately and using the full frequency-dependent absorption coefficient.

A process which enters the radiative transfer problem in a somewhat different way is scattering, in which a photon changes direction but not frequency. It is readily shown[2][3] that the effect of scattering on the radiative flux, when the Rosseland mean is applicable, is correctly included if in Eq. (1) $(1 - e^{-h\nu/kT})\kappa_\nu$ is replaced by $(1 - e^{-h\nu/kT})\kappa_\nu + \sigma_\nu$, where $\sigma_\nu = (1/2)\int_{-1}^{+1} (1 - t)\sigma_\nu(t)\, dt$ and $\sigma_\nu(t)$ is the cross section per unit mass for scattering through an angle arc cos t. When the Planck mean is applicable, scattering should not be included, since it is not an energy-loss mechanism.

In much of the present work, we use dimensionless variables, which we define here. In place of the photon frequency ν, we use the reduced frequency variable

$$u = \frac{h\nu}{kT} \,,$$

in terms of which

$$\frac{B_\nu\, d\nu}{B} = \frac{B_u\, du}{B} = \frac{15}{\pi^4} \frac{u^3}{e^u - 1}\, du \equiv b(u)\, du$$

and

$$\frac{\frac{\partial B_\nu}{\partial T}\, d\nu}{\int_0^\infty \frac{\partial B_\nu}{\partial T}\, d\nu} = \frac{15}{4\pi^4}\,\frac{u^4 e^u}{(e^u - 1)^2}\, du \equiv W(u)\, du\ .$$

The combination $\kappa_\nu\,(1 - e^{-h\nu/kT})$ which appears in the Rosseland and Planck means is actually the absorption coefficient corrected for induced emission and is often called κ'_ν. This gives the compact forms

$$\frac{1}{\kappa_R} = \int_0^\infty \frac{W(u)}{\kappa'_u}\, du\ ; \qquad \kappa_P = \int_0^\infty \kappa'_u b(u)\, du\ .$$

Since part of the absorption coefficient varies inversely with the cube of the frequency, we also use the quantity

$$D(u) = u^3 \kappa_u$$

and the Strömgren function

$$S(u) = \int_0^u \frac{W(x)x^3}{(1 - e^{-x})}\, dx\ ,$$

so that

$$\frac{1}{\kappa_R} = \int_0^\infty \frac{1}{D(u)}\,\frac{dS}{du}\, du\ ; \qquad \kappa_P = \frac{15}{\pi^4}\int_0^\infty D(u)e^{-u}\, du\ .$$

In the specification of the thermodynamic state of plasmas, it is most convenient to use as independent variables the thermal energy, kT (in electron volts when not otherwise stated), and the dimensionless degeneracy parameter

$$e^\alpha = \Gamma = \frac{2(2\pi mkT)^{3/2}}{h^3 N_e}$$

(where N_e is the number density of free electrons and m is the electron mass), which is, roughly, the phase space (in units of h^3) available per free electron, or the factor by which the existing electron density would have to be increased isothermally before strong degeneracy effects would set in. In all our applications, Γ is much larger than unity and the energy distribution of free electrons is nearly Maxwellian.

II. OCCUPATION NUMBERS AND THERMODYNAMIC PROPERTIES

The calculation of the populations of the various stages of ionization and excitation in a plasma is a prerequisite to finding its radiative properties. The thermodynamic properties, which are readily obtained from the relative populations, are also intrinsically useful. Our treatment of this part of the problem follows standard lines, except for the pressure-ionization recipe used. We start, for a pure element, with a set of energy levels, E_i; statistical weights, g_i; and net ionic charges, f_i. The Boltzmann and Saha equations give the thermal-equilibrium unnormalized population, P_i, of state i:

$$P_i = g_i \exp\left(\alpha f_i - \frac{E_i}{kT} + \sum_{f=0}^{f_i-1} J_f\right) , \tag{5}$$

where $\alpha = \ell n\, \Gamma$ and J_f is the pressure lowering of the ionization potential (in units of kT) of the ion species of charge f (thus, J_0 refers to the first ionization potential). J_f is evaluated in Section III. The normalized populations, or occupation numbers, p_i, are given by

$$p_i = \frac{P_i}{\sum_j P_j} , \tag{6}$$

and all of the thermodynamic properties are averages over the p_i. Thus, we have the mean and mean-square charges,

$$\langle z \rangle = \sum_i p_i f_i \quad \text{and} \quad \langle z^2 \rangle = \sum_i p_i f_i^2 ; \tag{7}$$

the total internal energy per nucleus,

$$\langle E \rangle = \sum_i p_i \left\{ E_i + kT \left[\frac{3}{2} (f_i + 1) - \sum_{f=0}^{f_i - 1} J_f \right] \right\} \qquad (8)$$

and so on. Since we are using kT and α (or Γ) as independent variables, the electron density, N_e, and electron pressure, $P_e = N_e kT$, are known at the start, but the mass density, ρ, and total pressure, P, require a knowledge of $\langle z \rangle$:

$$\rho = \frac{N_e M_1 A}{\langle z \rangle}; \qquad P = \left(1 + \frac{1}{\langle z \rangle} \right) P_e \, , \qquad (9)$$

where A is the atomic mass number and M_1 is the unit atomic mass.

The convergence of the partition-function sum $\sum_i P_i$ is secured by setting $P_i = 0$ for all states whose loosest electron is bound (in the isolated ion) by less than the perturbation, JkT, of the ionization potential. As will be seen later, the existence of such a cutoff is necessary only for the thermodynamic part of the calculation; the contribution of the high bound states to the sum giving the absorption coefficient, once $\langle z^2 \rangle$ has been determined, converges anyway.

For preliminary estimates, the concept of the "dominant potential" is useful.[4][5] It is defined, in our notation, as αkT, and in a thermal ensemble of ions the most abundant are those having ionization potentials close to the dominant potential. This permits $\langle z \rangle$, etc., to be estimated immediately. Stated differently, the one-electron levels with binding energies larger than the dominant potential are those which, on the average, are occupied nearly to their full capacity.

In our results we have not included the contribution of radiation to the pressure and internal energy. This contribution is simply additive; for equilibrium (black-body) radiation the energy density is

$$U_R = \frac{4\pi B}{c} = 137.3 \left(\frac{kT}{1 \text{ ev}} \right)^4 \frac{\text{ergs}}{\text{cm}^3} \, , \qquad (10)$$

and the radiation pressure is one-third of this, i. e.,

$$P_R = \frac{4\pi B}{3c} = 45.8 \left(\frac{kT}{1\ ev}\right)^4 \frac{dynes}{cm^2} . \qquad (11)$$

III. PRESSURE IONIZATION

In a material of finite density the potential distribution in and near a given ion is influenced not only by its own bound electrons, but also by free electrons, by neighboring ions, and (slightly) by neutral atoms. These perturbers produce effects of two kinds: their time-averaged effect is to alter the set of energy levels available to the ion in question, and their time-dependent effect is to broaden these levels both by shifting them back and forth adiabatically and by inducing transitions between them. The first effect, besides providing a natural cutoff to the bound-state partition function, effectively lowers all the ionization potentials and shifts the equilibrium occupation numbers in the direction of increased ionization. This effect, which is most important at high densities, is usually called pressure ionization. The second effect, pressure broadening, is discussed in Section VI.

Pressure ionization has often been treated by assigning to each ion a sphere occupying the ion's share of the total volume and containing the ion and enough free electrons to make the sphere's net charge zero. In the simplest form, the free-electron density is assumed uniform. Inside the sphere the potential due to other spheres is neglected. Thus, close encounters between ions are disregarded, and the picture is basically that of a crystal lattice, with strongly correlated ion positions. This picture may be expected to hold at high densities and low temperatures. At the opposite extreme is the case of nearly random ion positions; the first-order deviation from randomness leads to the Debye-Hückel potential, which is valid in the low-density, high-temperature limit. In this section we develop a theory of pressure ionization which yields the ion-sphere and Debye-Hückel results as limiting cases.

Consider a nucleus, Z, fixed in a sea of electrons and point ions at a temperature T. We wish to find the time-averaged potential distribution

around Z, and we assume for the present that only this average is felt by any one particle; that the potential distribution is spherically symmetric around Z; that it is determined by the time-averaged, spherically symmetric charge density; and that it changes only slightly within one particle wavelength. We describe the electrons by Fermi statistics and the ions by Maxwell statistics. These assumptions are those of the finite-temperature Thomas-Fermi (TF) atomic model, extended to include the neighboring ions. The electrostatic potential, $\phi(r)$, is then determined by the Poisson equation

$$\nabla^2\phi = \frac{1}{r}\frac{d^2}{dr^2}(r\phi) = -4\pi e\left(\sum_i z_i n_i - n_e\right),$$

where n_e is the electron density, n_i is the number density of ions of charge z_i, and

$$n_e(r) = n_e(\infty)\,\frac{F\left[\frac{e\phi(r)}{kT} - \alpha\right]}{F(-\alpha)}; \qquad n_i(r) = n_i(\infty)\exp\left(-z_i\,\frac{e\phi}{kT}\right);$$

$$F(\eta) = \int_0^\infty \frac{t^{1/2}\,dt}{e^{t-\eta}+1}; \qquad \phi(\infty) = 0; \qquad r\phi \to Ze \text{ as } r \to 0 .$$

The degeneracy parameter, α, is determined by

$$n_e(\infty) = \frac{2(2\pi mkT)^{3/2}}{h^3}\,\frac{2}{\sqrt{\pi}}\,F(-\alpha) .$$

In our applications α is always positive and appreciably larger than unity, i. e., the free electrons are nondegenerate and

$$\frac{2}{\sqrt{\pi}}\,F(-\alpha) \cong e^{-\alpha} << 1 .$$

Close to the nucleus, where $e\phi > \alpha kT$, there is a region of degenerate bound electrons which is, in fact, the ion core. The asymptotic ion densities $n_i(\infty)$ satisfy the condition of electrical neutrality, $\sum_i z_i n_i(\infty) = n_e(\infty)$.

Under the substitutions

$$y = \frac{e\phi}{kT}, \qquad x = \frac{r}{D}, \qquad \frac{1}{D^2} = \frac{4\pi e^2}{kT} \sum_i (z_i^2 + z_i) n_i(\infty)$$

(note that D is the Debye length including ions and electrons), the above equations take the nondimensional form

$$\frac{1}{x} \frac{d^2}{dx^2} (xy) = \frac{1}{z^* + 1} \left[\frac{F(y - \alpha)}{F(-\alpha)} - \frac{\langle z \exp(-zy) \rangle}{\langle z \rangle} \right],$$

where $\langle\ \rangle$ denotes an average, weighted with $n_i(\infty)$, over ion species, and $z^* \equiv \langle z^2 \rangle / \langle z \rangle$. The second term on the right side may be simplified with small loss of accuracy by noting that it is comparable with the first only for fairly small y; in this region,

$$\frac{\langle z \exp(-zy) \rangle}{\langle z \rangle} \cong \frac{\langle z(1 - zy + \cdots) \rangle}{\langle z \rangle} = 1 - z^* y + \cdots \cong e^{-z^* y},$$

so that to this approximation the assortment of ion species present can be replaced by a single fictitious species with charge z^*, which is never less than unity, even when $\langle z \rangle \to 0$. Our basic equation for the potential distribution is then

$$\frac{1}{x} \frac{d^2}{dx^2} (xy) = \frac{1}{z^* + 1} \left[\frac{F(y - \alpha)}{F(-\alpha)} - \exp(-z^* y) \right], \tag{12}$$

with boundary conditions $y(\infty) = 0$ and $xy \to Ze^2/(DkT) \equiv K_0$ as $x \to 0$.

Before proceeding to the solution of Eq. (12), let us consider what information we hope to extract from it. We will use the TF model solely to obtain the perturbing potential produced by free electrons and neighboring ions, and not to obtain all of the ionic properties. Since the density distribution of these perturbers depends somewhat on the bound-electron distribution, we must assume a bound-electron distribution in order to find the perturber distribution and its resulting potential. Having done so by means of the TF model, which approximates the average bound-electron distribution,

we may use this same perturbing potential in conjunction with better representations of the bound electrons, such as the experimental levels of isolated ions.

The perturbing potential, ϕ_f, satisfies a Poisson equation in which only the free-electron and ion densities appear, and in dimensionless form this equation is

$$\frac{1}{x}\frac{d^2}{dx^2}(xv) = \frac{1}{z^* + 1}\left[\frac{F(y - \alpha, y)}{F(-\alpha)} - e^{-z^* y}\right], \tag{13}$$

where $v = e\phi_f/kT$ and $F(y - \alpha, y) = \int_y^\infty (t^{1/2})/(e^{t+\alpha-y} + 1)\, dt$. (Note that $F(y - \alpha, y)/F(y - \alpha)$ is the ratio of free-electron density to total electron density in the TF model.) Unlike $y(x)$, which contains the nuclear potential, $v(x)$ is finite at the origin, and $v'(0) = 0$. Taking $v(\infty) = 0$, $v(x)$ will be negative; we let $-v(0)$ equal J. Then

$$v(x) = -J + \int_0^x S(t)t\, dt - \frac{1}{x}\int_0^x S(t)t^2\, dt, \tag{14}$$

where $S(x)$ is the right-hand side of Eq. (13), containing the solution $y(x)$ of Eq. (12). Hence, $J = \int_0^\infty S(x)x\, dx$. We can put Eq. (14) in a more convenient form,

$$v(x) = -\frac{1}{x}\int_0^\infty S(t)t^2\, dt + \frac{1}{x}\int_x^\infty S(t)t^2\, dt - \int_x^\infty S(t)t\, dt, \tag{15}$$

in which the first term, dominant at large x, may be identified as the asymptotic Coulomb potential of the total excess of free electrons over neighboring ions. It will be seen shortly that the total potential $y(x)$ vanishes exponentially at large x. Now the potential due to the nucleus and bound electrons alone, $y(x) - v(x)$, has an asymptotic Coulomb form dependent only on the net ionic charge; this permits evaluation of the first term of Eq. (15) without a knowledge of $y(x)$ all the way to the origin, provided that the ionic charge is known.

In the solution of the foregoing equations, the following expansions are useful; they are valid when α is somewhat larger than unity, so that $e^{\alpha} >> 1$ and the free electrons are nondegenerate (only this case is treated in what follows):

$$\frac{F(y - \alpha)}{F(-\alpha)} = \begin{cases} e^{y}\left[1 - 2^{-3/2}\, e^{y-\alpha}\,(1 - e^{-y}) + \cdots\right] & (y << \alpha) \\ \dfrac{4}{3\sqrt{\pi}}\, e^{\alpha}(y - \alpha)^{3/2}\left[1 + \dfrac{\pi^2}{8(y - \alpha)^2} + \cdots\right] & (y >> \alpha)\,, \end{cases}$$

$$\frac{F(y - \alpha, y)}{F(-\alpha)} = 2\sqrt{\frac{\pi}{y}} + e^{y}(1 - \operatorname{erf}\sqrt{y}) = \begin{cases} 2\sqrt{\dfrac{y}{\pi}}\left[1 + \dfrac{1}{2y} - \dfrac{1}{4y^2} + \cdots\right] & \\ & (y >> 1) \\ 1 + y + \dfrac{4}{3\sqrt{\pi}}\, y^{3/2} + \dfrac{1}{2}\, y^{2} + \cdots & \\ & (y << 1)\,. \end{cases}$$

From these and the form of Eq. (12), we can distinguish four regions of progressively smaller x (larger y).

Region A. The limiting form of Eq. (12) for large x, where $y << 1/z^*$, is

$$\frac{1}{x}\,\frac{d^2}{dx^2}\,(xy) = y\,,$$

with the solution $y = (C/x)\, e^{-x}$, which is the form of the Debye-Hückel potential. In the region where this holds, the charge densities of ions and electrons nearly cancel and most of the electrons are free.

Region B. Proceeding inward, if $z^* >> 1$, there is a region where $1/z^* << y << 1$ and the density of the ions and that of the bound electrons are small compared with that of the free electrons, which is approximately constant and equal to its asymptotic value. In this region, Eq. (12) becomes

approximately

$$\frac{1}{x}\frac{d^2}{dx^2}(xy) = \frac{1}{z^* + 1} ,$$

with the solution

$$y = \frac{A}{x} + B + \frac{x^2}{6(z^* + 1)} ,$$

in which A and B are arbitrary constants. This recalls the ion-sphere model with uniform free electrons.

Region C. In the next region, $1 \ll y \ll \alpha$, the bound electrons outnumber the free, but the occupation of the bound states is well below their capacity and the local kinetic-energy distribution is still approximately Maxwellian. The free-electron density is now larger than its asymptotic value. Here,

$$\frac{1}{x}\frac{d^2}{dx^2}(xy) \cong \frac{1}{z^* + 1} e^y .$$

Region D. Finally, in the ion core, $y \gg \alpha$ and most of the electrons are in fully occupied states. As the nucleus is approached, the bound-electron density diverges as $x^{-3/2}$ and the free-electron density as $x^{-1/2}$ (fictions peculiar to the TF model); the total potential, y(x), approaches $K_0/x + \text{const.} + 0(x^{1/2})$, and the perturbing potential, v(x), approaches $-J + 0(x^{3/2})$.

The procedure for obtaining v(x) should now be clear. There are basically three parameters in the problem: z^*, α, and K_0. More convenient than the last of these, for purposes of inward integration, is C, the normalization constant of the large-x solution. We can choose z^*, α, and C, integrate Eq. (12) inward, and obtain v(x) from Eq. (15). The net ionic charge, z, then is given by

$$-xv \xrightarrow[x\to\infty]{} \frac{ze^2}{DkT} \equiv K = \int_0^\infty S(t)t^2\, dt ,$$

and we recall that

$$-v(0) \equiv J = \int_0^\infty S(t)t\, dt\ .$$

We have carried out a number of numerical integrations for various values of z^*, $\alpha(\geq 2)$, and C. The results may be summarized as follows:

1. K and J are virtually independent of α for fixed z^* and C, even though K_0 is not. That is, as one might expect, the ionic charge rather than the nuclear charge determines most of the free-electron distribution.
2. v(x) is nearly equal to its value at the origin, -J, through all of region D (the core) and much of region C. Thus, most of the bound states of the perturbed ion, including all the fully occupied ones in the core, are simply shifted relative to the continuum by the same amount; their wave functions are like those of the isolated ion and their ionization potentials are lowered by JkT. This result contrasts with that of Keller and Meyerott;[6, 7] what they actually found was the outer screening by all the electrons--and the bound contribution is already present in the isolated ion.

A very simple approximate solution for Eqs. (12) and (15) is readily obtained by assuming that only regions A and B need be considered, i. e., that all the bound electrons are at the origin and the free-electron density is approximately uniform. Then Eq. (12) is just

$$\frac{1}{x}\frac{d^2}{dx^2}(xy) = \frac{e^y}{z^* + 1}\left[1 - e^{-(z^*+1)y}\right]\ .$$

For large z^* we approximate the right side by

$$y \quad \text{when } (z^* + 1)y < 1 \quad \text{(region A)}\ ,$$

$$\frac{1}{z^* + 1} \quad \text{when } (z^* + 1)y > 1 \quad \text{(region B)}\ ;$$

and letting x_1 denote the transition point, we require y and dy/dx to be continuous at x_1. At small x, $y \to (K/x) - J + \cdots$, where to this approximation the first term is the Coulomb potential of the ion and the next is the screening potential evaluated at the origin, i. e., the reduction in ionization potential (in units of kT) produced by the free electrons and ions. Using the solutions in regions A and B, which are, respectively,

$$y = \begin{cases} \dfrac{C}{x} e^{-x} & (x > x_1) \\ \dfrac{K}{x} - J + \dfrac{x^2}{6(z^* + 1)} & (x < x_1) , \end{cases}$$

and the continuity conditions

$$Ce^{-x_1} = K - Jx_1 + \frac{x_1^3}{6(z^* + 1)} ,$$

$$Ce^{-x_1} = J - \frac{x_1^2}{2(z^* + 1)} ,$$

we get

$$J = \frac{x_1}{z^* + 1}\left(1 + \frac{x_1}{2}\right) = \frac{1}{2(z^* + 1)}\left[(x_1 + 1)^2 - 1\right] ,$$

$$K = \frac{x_1}{z^* + 1}\left(1 + x_1 + \frac{x_1^2}{3}\right) = \frac{1}{3(z^* + 1)}\left[(x_1 + 1)^3 - 1\right] \geq J ,$$

or, eliminating x_1,

$$2(z^* + 1)J + 1 = \left[3(z^* + 1)K + 1\right]^{2/3} , \qquad (16)$$

which for small $(z^* + 1)K$ becomes $J = K$, and for large $(z^* + 1)K$ becomes $J = [1/2(z^* + 1)]\,[3(z^* + 1)K]^{2/3}$. Defining the ion-sphere radius, a, for an ion of charge z by the condition $4\pi a^3/3 = z/n_e(\infty)$ and recalling the

expression for the Debye length (D),

$$\frac{1}{D^2} = \frac{4\pi e^2}{kT} (z^* + 1)\, n_e(\infty) ,$$

we see that the parameter $3(z^* + 1)K$ is just

$$3(z^* + 1)\, \frac{ze^2}{DkT} = \frac{3z}{4\pi D^3 n_e(\infty)} = \left(\frac{a}{D}\right)^3 = \frac{\text{ion sphere volume}}{\text{Debye sphere volume}} .$$

When this parameter is small,

$$J \to \frac{ze^2}{DkT} = K ;$$

when it is large,

$$J \to \frac{3}{2}\, \frac{ze^2}{akT} .$$

These values of J are, respectively, the results of the Debye-Hückel and ion-sphere models. Very roughly, one may say that the model giving the smaller depression of the ionization potential is closer to the truth.

The scaling in $z^* + 1$ which appears above suggests plotting the results of the numerical integrations in the form $(z^* + 1)J$ versus $(z^* + 1)K$, with z^* as a parameter. When this is done, it is found that the curves for all values of z^* give J-values which are (1.06 ±0.08) times the J given by Eq. (16), provided that $(z^* + 1)K \leq 3$ (as is the case for all of the values of α, T, and Z we are concerned with in this report).

In our calculations of the equilibrium occupation numbers, we proceed as follows: for a given temperature and α, an initial set of occupation numbers is obtained from the Boltzmann and Saha equations, using ionization potentials lowered by an amount JkT calculated with $z^* = 1$, and including all the ionic states bound by more than JkT. Then z^* and the Debye length, D, are found, as is K for each z; this fixes J for each z. In each stage of

ionization we then discard all bound states in which the loosest electron is bound by less than JkT in the isolated ion, and we lower the ionization potential by JkT; the new set of states and ionization potentials, inserted into the Boltzmann and Saha equations, gives new occupation numbers. The iteration converges rapidly and one cycle is usually enough. In the above, we take z as the ionic charge with the electron in question removed; for example, the first ionization potential is lowered by JkT calculated for $z = 1$.

Numerical experiments have been performed which evaluate the sensitivity of the thermodynamic properties and of the opacity to J. The results show that changing all J's by 50% changes thermodynamic properties by $\sim 1\%$ and opacities by $\sim 4\%$. For this reason, in all of our work we have simply used 1.06 times the J given by Eq. (16).

IV. CONTINUOUS ABSORPTION COEFFICIENTS

The total photon absorption coefficient (not including scattering) at any frequency of interest in our temperature range has, in general, contributions from three types of elementary transitions involving electrons: (1) photoionization (bound-free), (2) inverse bremsstrahlung (free-free), and (3) line absorption (bound-bound). The cross sections for the first two types of transitions are said to comprise the "continuous" part of the absorption coefficient; hydrogenlike expressions for them can be found in any text on stellar atmospheres or interiors (e.g., see Chandrasekhar,[1] Aller,[8] Unsöld,[9] and Schwarzschild[10]). Straightforward but approximate generalizations to nonhydrogenic atoms and ions have been employed in all calculations of plasma opacities known to us, and ours will be no exception. Physically, it is assumed that all radial integrals which enter transition matrix elements can be adequately evaluated by using hydrogenic wave functions scaled to some effective charge that is the same in the initial and the final states of a given transition. No matter how this effective charge is chosen, this assumption does violence to the frequency distribution of oscillator strength from certain initial states (an extreme example is the ground state of any neutral alkali); we feel that this is by far the most serious limitation on the over-all accuracy of our calculations. (Some compensation of errors occurs, of course, since the hydrogenic and actual oscillator strengths are subject to the same sum rule.) Calculations such as those of Varsavsky[11] and of Burgess and Seaton,[12] who do not make the equal-effective-charge assumption, show deviations from the scaled hydrogenic results for individual transitions which are large compared with the additional error made by setting the hydrogenic Gaunt factors equal to unity, which we have done throughout.

Consider the photoelectric ejection of an electron of type j from an

atom or ion in state i, leaving a residual ion in state k. We choose the effective charge Z_j for this transition as determined by the ionization potential of electron j, evaluated without pressure-ionization corrections (this is because outer screening causes Z_j to be an underestimate of the charge which determines the initial wave function, and pressure ionization effectively increases outer screening). This is the same choice used by Armstrong, Holland, and Meyerott[13] and by Bernstein and Dyson.[14] Thus,

$$\frac{Z_j^2}{n_j^2}\,\mathrm{Ry} = I_j = E_k - E_i \,, \tag{17}$$

and the scaled hydrogenic result for the contribution of this transition to D(u) is

$$D_j(u) = D_{ff}\,\frac{\Gamma}{\langle z^2\rangle}\,\frac{kT}{Ry}\,\frac{p_i m_j}{n_j}\,u_j^2 \,, \qquad \text{for } u > u_j - \Delta u_j \,, \tag{18}$$

$$= 0 \qquad \text{for } u < u_j - \Delta u_j \,;$$

where p_i = fractional population of state i,

m_j = number of equivalent j-type electrons in state i,

n_j = principal quantum number of electron j,

$u_j = I_j/kT$,

Ry = Rydberg energy = 13.60 ev,

$\langle z^2\rangle$ = mean squared ionic charge in the plasma,

Δu_j = reduction in I_j/kT owing to pressure ionization,

and the free-free part of D(u) is

$$D_{ff} = \frac{\langle z^2\rangle}{A}\left(\frac{Ry}{kT}\right)^2 \frac{1}{\Gamma}\left[\frac{64\pi}{3\sqrt{3}}\,\frac{1}{137}\,\frac{a_0^2}{M_1}\right], \tag{19}$$

which is the result of taking the ionic charge as the effective charge for every free-free transition. (The bracketed quantity is 4.76×10^6 cm^2/g.)

We can determine the part of D_{ff} arising from free-free transition in the field of ions in state k:

$$D_{ff,\,k} = D_{ff}\,\frac{p_k f_k^2}{\langle z^2 \rangle}\ , \tag{20}$$

where f_k is just the net ionic charge of state k. Now the ratio p_i/p_k is given by the Boltzmann-Saha equation:

$$\frac{p_i}{p_k} = \frac{g_i}{g_k}\,\frac{1}{\Gamma}\,e^{u_j - \Delta u_j}\ , \tag{21}$$

where the g's are statistical weights. Hence,

$$\frac{D_j}{D_{ff,\,k}} = \frac{kT}{Ry}\,\frac{m_j}{n_j}\,\frac{u_j^2}{f_k^2}\,\frac{g_i}{g_k}\,e^{u_j - \Delta u_j}\ . \tag{22}$$

So far, we have made no restrictions on the nature of the ionic states involved. We digress here and apply Eq. (22) to the determination of the absorption coefficient at low frequencies, so that large values of n_j are the only ones that contribute. For these states, since they are nearly hydrogenic, $Z_j \cong f_k$, $m_j = 1$, and $g_i/g_k = 2n_j^2$. Then

$$\frac{D_j}{D_{ff,\,k}} \cong \frac{2 f_k^2 Ry}{n_j^3 kT}\,e^{u_j - \Delta u_j} \qquad \text{for} \qquad u > u_j - \Delta u_j\ , \tag{23}$$

and the part of D(u) due to <u>all</u> high bound states j on a core k, which we call $D_{bf,\,k}$, is given by

$$\frac{D_{bf,\,k}}{D_{ff,\,k}} = \sum_j \frac{D_j(u)}{D_{ff,\,k}}\ , \tag{24}$$

where the summation covers only the j's for which $u > u_j - \Delta u_j > 0$, since

the higher bound states have been pressure-ionized. Next, noting that

$$\frac{du_j}{dn_j} = -\frac{2f_k^2 Ry}{n_j^3 kT} ,$$

we replace the sum by an integral over u_j, recalling that in our approximate pressure-ionization theory, Δu_j is independent of j for fixed k. We obtain

$$\frac{D_{bf,k}}{D_{ff,k}} = e^u - 1 , \tag{25}$$

which implies for the whole continuous absorption coefficient that

$$D(u) = D_{ff} e^u \tag{26}$$

out to some value of u at which the approximations based on large n start to break down. This result is given by Unsöld[9] and by Raĭzer[15] and is also to be found in Eddington's book;[4] we derive it here to show its invariance to the altering of the potential well implied by pressure ionization. Actually, this frequency dependence holds classically for any potential which deflects impinging electrons abruptly enough, since classically an electron radiates only while accelerated, so an instantaneous acceleration produces a uniform frequency spectrum of radiated power. Identifying this with the spontaneous emission coefficient and using the detailed balance relation Eq. (3), we obtain $\kappa_u \sim e^u/u^3$.

Equation (26) is a surprisingly accurate representation of the monochromatic continuous absorption coefficients of air at temperatures of 2 to 20 ev calculated by Armstrong, Holland, and Meyerott,[13] generally deviating strongly only at values of u which are too large to affect seriously the Rosseland mean opacity. If Eq. (26) is inserted into the expression for the Rosseland mean, there results simply

$$\kappa_R = 1.15\, D_{ff} , \tag{27}$$

with D_{ff} given by Eq. (19). This provides a quick estimate of the Rosseland mean (neglecting scattering and line absorption), once $\langle z^2 \rangle$ is determined for given Γ and T. Raĭzer[15] couples Eq. (27) with an approximate prescription for $\langle z^2 \rangle$, but when a detailed occupation-number calculation is available, one may use the accurate $\langle z^2 \rangle$. When this is done using the work of Armstrong,[16] it is found that Eq. (27) reproduces his Rosseland mean opacities to ~30% at kT = 5 and 10 ev for all of his density range ($\sim 10^{-2}$ to 10^{-8} g/cm^3); at kT = 2 and 20 ev the agreement is good at low densities but deteriorates toward higher densities, with Eq. (27) predicting opacities which are too large, but not by an order of magnitude. At very high temperatures, however, where $u_K = Z^2 Ry/kT \ll 1$, Eq. (22) shows that bound-free absorption is negligible, and (still neglecting scattering)

$$\kappa_R = \frac{D_{ff}}{S(\infty)} = \frac{D_{ff}}{196.5} , \tag{28}$$

so that here Eq. (27) overestimates κ_R by a factor of 226. As u_K increases, κ_R / D_{ff} increases--mostly because of K-shell absorption at first--and reaches a value of 1/10 at $u_K \cong 1.8$, so that Eq. (27) should be within an order of magnitude of the correct continuous opacity (without scattering) whenever $u_K \geq 2$.

Returning now to Eq. (18), we may introduce an index, J, which labels a specific photoelectric transition, i. e., which specifies the initial state i and the initial quantum numbers n_j and ℓ_j of the ejected electron. The total continuous D(u) is then obtained by summing over all possible photo-electric and free-free transitions:

$$D(u) = D_{ff} \left[1 + \frac{\Gamma}{\langle z^2 \rangle} \frac{kT}{Ry} \sum_J \frac{p_J m_J}{n_J} u_J^2 H(u - u_J + \Delta u_J) \right] , \tag{29}$$

where the unit step function $H(x) = \begin{cases} 0 & (x < 0) \\ 1 & (x > 0) \end{cases}$ takes care of the condition $u > u_J - \Delta u_J$, and the occupation-number calculation has set $p_J = 0$ whenever the initial state is pressure-ionized. Each term in the sum gives rise to an "edge," or jump, in the absorption coefficient.

The analogous expression of Armstrong, Holland, and Meyerott[13] differs from Eq. (29) in two respects: each term carries a Gaunt factor, $g(n_j \ell_j)$, and each term in which $m_J > 1$ is replaced, in general, by several terms weighted with fractional parentage coefficients which add up to m_J and depend on the quantum numbers L and S. The effect of the first difference is to redistribute strength among the edges corresponding to the same n_j and different ℓ_j, leaving the total strength almost unchanged (since the weighted average over ℓ of $g(n\ell)$ is close to unity); and the second difference increases the number of edges, again without materially affecting the total strength. Test calculations of the continucus absorption coefficient of oxygen, using unit Gaunt factors and a level scheme in which each configuration is lumped at its center of gravity, have exhibited only minor differences (~20%) in monochromatic absorption coefficients and negligible differences in mean opacities when compared with Armstrong's results. We suspect this is partly because the frequencies contributing heavily to the Rosseland mean are around $u \sim 5$ and the transitions with $m_J > 1$ tend to have edges $u_J \gtrsim \alpha$ (since the electron is being ejected from a substantially populated level); and usually $\alpha > 5$. In our calculations we have therefore used configurations as our energy levels and neglected the Gaunt factors.

The scattering contribution may be added at this point. We have taken it as the classical Thomson approximation to incoherent Compton scattering by free electrons. Since scattering by bound electrons occurs and is of the same order of magnitude, and since scattering dominates only when most of the electrons are free anyway, we have assumed that the Thomson cross section applies to all electrons, bound and free. The resulting contribution to D(u) is

$$D_s(u) = \frac{u^3}{1 - e^{-u}} \frac{Z}{A} \left[\frac{8\pi}{3} \frac{r_0^2}{M_1}\right] , \qquad (30)$$

where r_0 = classical electron radius; the bracketed quantity is 0.398 cm^2/g.

V. EFFECT OF LINES ON LOCALLY AVERAGED ABSORPTION COEFFICIENTS

In most cases, when line absorption has an important effect on frequency-averaged absorption coefficients such as the Rosseland and Planck mean opacities, the effect is due to a large number of lines scattered through the spectrum. Under such circumstances, the concept of a locally averaged absorption coefficient is pertinent. By this is meant an average with respect to frequency, taken over an interval large enough to contain several lines but small enough that the continuous absorption coefficient, Planck function, average line strength per unit frequency interval, etc., do not change substantially within the interval. We will consider two such averages, the "local Rosseland mean" and "local Planck mean," defined respectively by

$$\kappa_R(u) = \frac{\int_{\Delta u} du'}{\int_{\Delta u} \frac{du'}{\kappa(u')}}$$

and

$$\kappa_P(u) = \frac{\int_{\Delta u} \kappa(u')du'}{\int_{\Delta u} du'} ,$$

where the integration range, Δu, of the frequency variable u' is centered on u and satisfies the above conditions, and two models of the line absorption coefficient. The statistical model, in which the lines are randomly located, has been worked out by Mayer;[3] Elsasser's model,[17] with uniformly spaced lines, is another case offering some analytic tractability. In this section we will compare the results of using these two models to compute the local mean absorption coefficients.

We consider a frequency interval in which the absorption coefficient consists of a continuous part, which we take to be constant and normalize to unity, and a line part denoted by r(u); we use the reduced photon frequency variable $u = h\nu/kT$. Let there be N identical lines in an interval Nd, with the center of the n^{th} line at u_n; let r_n be the contribution of the n^{th} line to r. Since all the lines are alike except for location, r_n depends only on $u - u_n$ Define the strength, S, of the n^{th} line as $\int_{-\infty}^{\infty} r_n \, du$. The average line strength per unit frequency interval (in the present dimensionless units) is $R = \bar{r} = S/d$; hence, the local Planck mean is just 1 + R, which is independent of line shape. Schwarz' inequality demonstrates that 1 + R is also an upper bound to the local Rosseland mean; it is the result of complete blending of the lines. A lower bound is, of course, unity, corresponding to infinitely sharp lines.

To calculate the local Rosseland mean, it is necessary to specify the shape of the lines and some properties of their relative positions. Here we will consider lines with Lorentz (dispersion) profiles such as result from natural and collision broadening. Then

$$r_n(u) = \frac{S}{\pi} \frac{w}{(u - u_n)^2 + w^2} ,$$

where w is the half-intensity half-width in units of kT. In the statistical model it is assumed that the N values $u_n (n = 1, 2, \cdots N)$ are randomly located in the frequency interval Nd, so that the joint probability that the center of the first line is in du_1 at u_1, the second in du_2 at u_2, etc., is just

$$(Nd)^{-N} \prod_{n=1}^{N} du_n ,$$

and the value of r(u) with this arrangement is $\sum_n r_n$. The average of $1/(1 + r)$ over all arrangements is

$$\left\langle \frac{1}{1+r} \right\rangle = (Nd)^{-N} \int\int\int \cdots \int \frac{1}{1 + \sum_n r_n} \prod_n du_n = (Nd)^{-N} \int_0^{\infty} dt \, e^{-t} \prod_n \int e^{-r_n t} \, du_n ,$$

where the fact that $1/(1 + r) = \int_0^\infty e^{-(1+r)t}\, dt$ has been used instead of Mayer's approximation

$$\frac{1}{1 + r} \cong \sum_{i=1}^{4} a_i e^{-b_i r} .$$

Now all of the integrals $\int e^{-r_n t}\, du_n$ are identical, so

$$\left\langle \frac{1}{1 + r} \right\rangle = \int_0^\infty dt\, e^{-t} \left[\frac{1}{Nd} \int e^{-r_1 t}\, du_1 \right]^N = \int_0^\infty dt\, e^{-t} \left[1 - \frac{1}{Nd} \int (1 - e^{-r_1 t})\, du_1 \right]^N ,$$

since the integral over u_1 covers the interval Nd. As N becomes large, with d (the average line spacing) fixed, this integral becomes independent of N and u, and we get

$$\left\langle \frac{1}{1 + r} \right\rangle = \int_0^\infty dt\, e^{-t} e^{-G(t)} ,$$

where $G(t) = (1/d) \int_{-\infty}^{\infty} (1 - e^{-r_1 t})\, du_1$. For Lorentz profiles, G(t) can be evaluated as

$$G(t) = RtF\left(\frac{2Rt}{\beta}\right); \qquad \beta = \frac{2\pi w}{d} ;$$

$$F(x) = \frac{2}{\pi x} \int_0^\infty (1 - e^{-x/(1+y^2)})\, dy$$

$$= e^{-x/2} \left[I_0\left(\frac{x}{2}\right) + I_1\left(\frac{x}{2}\right) \right]$$

$$= \begin{cases} 1 - \dfrac{x}{4} , & x \ll 1 \\ \dfrac{2}{\sqrt{\pi x}} , & x \gg 1 , \end{cases}$$

and $\langle 1/(1 + r) \rangle$ depends only on the two parameters R and β. Since in this

case the averaging over u has in effect already been carried out, we can identify $\langle 1/(1 + r)\rangle$ with the reciprocal of the local Rosseland mean, and denote it by $T_M(R, \beta)$.

In Mayer's report[3] a further result obtained by Jacobsohn is presented: if the line strengths are not identical but have an exponential probability distribution with a mean value S, the resulting $T_M(R, \beta)$ differs only in that the function F(x) must be replaced by $1/\sqrt{1 + x}$, which is numerically quite similar.

We turn now to Elsasser's model,[17, 18] in which the line centers are equally spaced, so that

$$r(u) = \frac{Sw}{\pi} \sum_{n=-\infty}^{+\infty} \frac{1}{(u - nd)^2 + w^2}$$

is periodic in u. As Elsasser showed, this can be summed into a very simple form:

$$r(u) = R \frac{\sinh \beta}{\cosh \beta - \cos \theta} ,$$

where, as before, $R = S/d$; $\beta = 2\pi w/d$; and $\theta = 2\pi u/d$. To average over u, we need only average over θ from 0 to π. Thus,

$$\langle r \rangle = R ,$$

$$\left\langle \frac{1}{r} \right\rangle = \frac{1}{R} \coth \beta ,$$

$$\left\langle \frac{1}{1 + r} \right\rangle = T_E(R, \beta) = 1 - \frac{R}{\sqrt{R^2 + 1 + 2R \coth \beta}} .$$

Comparing T_M with T_E for the same R and β, we find some interesting results. For example, in the limit of small β,

$$T_M \cong 1 - \sqrt{\frac{\beta R}{2}} + \frac{1}{\pi} \beta R + \cdots ,$$

$$T_E \cong 1 - \sqrt{\frac{\beta R}{2}} + \frac{1}{2}\left(\frac{\beta R}{2}\right)^{3/2} + \cdots ,$$

and at large β,

$$T_M \cong \frac{1}{1+R}\left[1 + \left(\frac{R}{1+R}\right)^2 \frac{1}{\beta} + \cdots\right] ,$$

$$T_E \cong \frac{1}{1+R}\left[1 + \left(\frac{R}{1+R}\right)^2 2e^{-2\beta} + \cdots\right] ,$$

so that the leading terms at extreme values of β are identical, but for intermediate β's the statistical array gives larger T, i. e., a smaller local Rosseland mean. Physically, this stems from the occurrence of occasional large "windows" in the statistical array.

Of perhaps more relevance to the present study is the fact that in either model the parameter β appears instead of w and d separately. This means that changes in the number of lines per unit frequency interval affect the opacity in much the same way as changes in line width, if the strength per unit frequency interval, R, is fixed.

Cases sometimes occur in which the locally averaged absorption coefficient as used above is not meaningful. An example is iron at a temperature of 1000 ev, which was treated by Mayer.[3] A large part of the line effect comes from a fairly closely spaced group of strong $1s \rightarrow 2p$ lines with centers in a fairly small frequency interval, and wings which extend far outside the interval. In the wing region, containing no line centers, the foregoing recipes would give no line contribution. Mayer used the statistical method in a form which correctly takes the wing effect into account; at distances from the group of centers large compared with the spread of the group, the wing absorption coefficient is independent of everything except the product of strength and width summed over all the lines in the group, i. e., the total strength times a strength-weighted average width. The effect of this group on the opacity is then insensitive to number of lines, but still depends on width, in contrast to the local averages, which depend on both in the same way. Generalizing, we may say that the change in the opacity produced by splitting each line in the spectrum into N components should be at most equal to the change produced by multiplying all widths by a factor N.

VI. LINE BROADENING

The theory of the broadening of lines in plasmas has developed considerably in recent years, partly owing to its importance in optical measurements of the electron densities of laboratory plasmas. A comprehensive review by Baranger[19] will shortly be available, and we extract from it the bulk of this section.

Two sources of line width which persist to vanishing densities are Doppler broadening and natural broadening. However, both these effects are quite small in our range of interest. The Doppler width is $\sim\sqrt{kT/AM_1c^2}$ times the line frequency, and even in hydrogen at a temperature of 100 ev, this ratio is only $\sim 3 \times 10^{-4}$. The natural width is roughly $(1/137)(Z/137)^2$ times the spacing of lines in a series, and is negligible except possibly at very large Z. We have neglected both these broadening mechanisms.

Pressure broadening is the name given to the line width produced by interactions between the radiator and other particles. In plasmas which are even slightly ionized, neutral perturbers may be neglected and the relevant interactions are Coulombic. Usually, most of the broadening is due to perturbers which are distant enough that the radiator feels only a homogeneous electric field which changes in time as the perturber passes by, and in all practical cases it is permissible to treat the perturber's motion classically. The spectrum radiated by the total system is then calculated quantum-mechanically. The theory simplifies considerably in the limiting cases of slow or fast perturber motion, which give rise to the "quasi-static approximation" and the "impact approximation," respectively.

It turns out that the electron perturbers always obey the impact approximation in a plasma at nondegenerate densities ($\Gamma >> 1$). This approximation implies that the typical collision is weak and may be calculated using perturbation theory; occasional strong collisions may also

occur. The result is that an isolated line acquires a Lorentz shape with a width proportional to the electron density, and a shift which is usually of the order of the width. When a closely spaced group of states gives rise to a group of overlapping lines, there are some asymmetric terms in the spectrum besides the Lorentz profiles. Most of the electron width is usually due to collision-induced transitions involving the upper state of the line, which give it a finite lifetime.

Ion perturbers, on the other hand, can often be treated in the quasi-static approximation; this is true especially for the ions that give rise to the wings of the line profile. The effect of the ions is then a static Stark effect (which shifts levels adiabatically but induces no transitions), averaged over the probability distribution of the electric field produced at the radiator by the ions. The resulting profile depends on this probability distribution and on the Stark pattern of the line.

The combined effect of ions and electrons is usually calculated by choosing an ionic field, finding the corresponding Stark pattern, broadening it by electron impacts, and then averaging over field strengths. Finally, possible corrections for ion motion are evaluated. This program has been carried out for a large number of lines of hydrogen and helium, and the resulting profiles are in excellent agreement with arc and shock-tube experiments, in which temperatures of 1 to 4 ev are produced.

In our application we are mostly interested in the line absorption coefficient outside the line cores, in the far wings. Asymptotic wing profiles obtained using the full ion-electron broadening theory show that here the ion and electron contributions are additive, and that the ion part falls off more rapidly with distance from the line center. This is especially true when the radiator is itself an ion, since the Coulomb repulsion between the ions inhibits the close encounters which produce the line wing. The electron-width calculation also is different in this case, since the classical perturber trajectories are hyperbolae instead of the straight lines which electrons follow near neutral atoms; somewhat surprisingly, the Coulomb attraction decreases the electron width slightly.

The evaluation of the electron width of lines emitted (or absorbed) by ions, and the accompanying asymmetric contributions, are given in detail by Baranger and Stewart.[20, 21] The width is proportional to the total inelastic cross section of the ion in the upper state of the line, and this in turn is given by perturbation theory in terms of the same dipole matrix elements as determine the line strengths, and of a Gaunt factor for bremsstrahlung which takes care of quantum corrections to the perturber's motion. When this is set equal to unity, a sum rule permits the evaluation of the cross section in terms of the mean square radius of the optical electron's wave function. In our problem, most of the lines will be high series members with upper states which are approximately hydrogenic, and the final result is thus

$$w = \frac{2.0}{\Gamma} \frac{n^4}{z^2}, \tag{31}$$

where w = half-intensity half-width in units of kT,

n = principal quantum number of optical electron in upper state,

z = core charge of ion = net ionic charge plus 1.

The total line absorption coefficient is composed of a Lorentz profile for each line in the spectrum, some asymmetric terms, and some ion-broadening contributions. The relative importance of these can be assessed by considering a single series of lines having a common lower state and upper states which differ only in n. The asymmetric terms will tend to cancel each other at large n, where the line series becomes nearly periodic; they are relatively most important midway between line centers. We have evaluated them for some representative cases at low n, and find that even there they contribute only ~20% as much as the Lorentz part midway between centers. Likewise, the ion contribution can be overestimated by assuming linear Stark effect, and turns out to be negligible except very near the line cores, where the absorption coefficient is high already. Griem[22] has shown that for the higher series members, electron broadening dominates even in neutral hydrogen, which should be the case most favorable to ion broadening.

We have therefore kept only the Lorentz profiles, with half-widths determined as above. These widths are about half as large as those given by Sternheimer's result, which was used by Moszkowski and Meyerott[23] and by Cox.[24] Though our expression was derived for lines emitted by ions, it predicts widths for neutral helium lines which are in qualitative agreement with the accurate electron widths calculated by Griem, Baranger, Kolb, and Oertel;[25] our widths are larger by a factor of generally less than 2.

VII. LINE SERIES ABSORPTION COEFFICIENTS

In this section we indicate how the line contribution is incorporated into the total absorption coefficient, using the pressure-broadened Lorentz profiles. The most straightforward (and longest) procedure would be to simply construct a list of all possible lines with their frequencies, oscillator strengths, widths, and initial-state populations, and at each frequency to find the sum of the absorption coefficients of all the profiles. This procedure is fairly redundant because the line strengths are closely related to those of the photoelectric continua; the high series members at frequencies just below an edge frequency have an average oscillator strength per unit frequency interval which is the same as that of the continuum just above the edge. (This results from the correspondence principle.) In the same hydrogenlike, unit-Gaunt-factor approximation which we have used for the continua, the $1/u^3$ frequency dependence of the continuum extends also to the average strength per frequency interval of the whole line series.

Using these facts, we can group the lines into series, with one series associated with each photoelectric transition. (Actually, there are in general two, since the optical electron can either increase or decrease its orbital angular momentum, ℓ, by one unit; the lines of the second have nearly the same frequencies and widths as those of the first but are far weaker, and we ignore them.) Along such a series, labeling the lines by the principal quantum number, n, of the optical electron in the upper state, the line width grows as n^4, whereas the line spacing shrinks. Eventually, the width exceeds the spacing and the series has coalesced to form a continuum. Typically, this occurs at a lower frequency than that of the perturbed edge $(u_J - \Delta u_J)$ which comes from the pressure-ionization correction to the edge position, so when lines are used the latter is superfluous.

(Of course, pressure ionization must still be included in the occupation-number calculation.)

We have assigned the line frequencies u_n by assuming hydrogenic upper states, i.e.,

$$u_n = u_J - \frac{(f_J + 1)^2 Ry}{n^2 kT} , \tag{32}$$

where f_J = net ionic charge of initial state of transition J,

u_J = unperturbed edge frequency of transition J.

This does not imply hydrogenic line frequencies, since u_J is determined by an effective charge Z_J, which in general is larger than $f_J + 1$.

We now introduce a closed approximation for the absorption coefficient due to an entire series. Recalling Elsasser's expression for a uniform band of lines

$$\frac{r(u)}{\langle r \rangle} = \frac{\sinh \beta}{\cosh \beta - \cos \theta} \tag{33}$$

with β fixed and θ linear in u, we replace β and θ by smooth functions of u such that

$$\beta(u_n) = 2\pi w_n / d_n , \tag{34}$$

$$\theta(u_n) = 2\pi n , \tag{35}$$

and use for d_n (the local line spacing) the large-n approximation

$$d_n = \frac{2(f_J + 1)^2}{n^3} \frac{Ry}{kT} . \tag{36}$$

Inserting our previous expression for w_n (Eq. (31)) and eliminating n by Eq. (32), we obtain

$$\beta_J(u) = \frac{2\pi}{\Gamma} \left(\frac{Ry}{kT}\right)^{5/2} (f_J + 1)^3 (u_J - u)^{-7/2} , \tag{37}$$

$$\theta_J(u) = 2\pi \left(\frac{Ry}{kT}\right)^{1/2} (f_J + 1)\,(u_J - u)^{-1/2}\,, \tag{38}$$

and the contribution to D(u) of the J^{th} photoelectric transition and its associated line series is now

$$D_J(u) = D_{ff}\,\frac{\Gamma}{\langle z^2\rangle}\,\frac{kT}{Ry}\,\frac{p_J m_J}{n_J}\,u_J^2\,R_J(u)\,, \tag{39}$$

where the frequency-dependent part, which replaces the step function H of Eq. (29), is

$$R_J(u) = \left\{\begin{array}{ll} 1 & (u > u_J) \\ \dfrac{\sinh \beta_J(u)}{\cosh \beta_J(u) - \cos \theta_J(u)} & (u < u_J) \end{array}\right\}. \tag{40}$$

This expression, which might be called an "osculating Elsasser band," generates Lorentz profiles when β is very small, overlapping lines when β is fairly small, and a continuum when β is larger than about 1. The Lorentz profiles occur at the frequencies u_n and have the correct widths and strengths. Comparison of expressions like $R_J(u)$ with actual sums of Lorentz profiles has revealed no serious distortion introduced by this approximation; all that occurs is a slight asymmetry in each line.

One further point must be noted. At some low frequency $u = u_J - [(f_J+1)^2 Ry]/[n_J^2\,kT]$ (where n_J is the initial principal quantum number of the optical electron), $R_J(u)$ will generate a fictitious same-shell line of grossly large oscillator strength (~100 in typical cases). The actual oscillator strengths of same-shell lines, when estimated using hydrogenic dipole matrix elements and actual line frequencies, turn out to be too weak to affect the opacity in our temperature range appreciably, since such lines occur at low frequency and have small widths. Accordingly, we discard the fictitious line by introducing a cutoff:

$$R_J(u) = 0 \qquad \text{for} \qquad u < u_J - \frac{(f_J + 1)^2 Ry}{\left(n_J + \frac{1}{2}\right)^2 kT} \,. \tag{41}$$

The position of the cutoff is reasonably irrelevant since in practical cases $R_J(u)$ is usually small enough at the cutoff so that D(u) is dominated by other transitions and the free-free contribution.

When the line contribution is represented in the way we have just described, the separation of the absorption coefficient into "line" and "continuous" parts is rather artificial. The "continuous" opacity could be defined as the result of placing each edge at the position $u_J - \Delta u_J$ (this is the usual convention), or at the position where $\beta_J(u) = 1$, or could be defined by some other criterion. In our results the "continuous" opacities we quote are the result of setting all the line widths equal to zero, so that the edges are at their unperturbed (zero-density) positions, u_J, and all lines, including the fully merged ones, are omitted.

VIII. ENERGY LEVELS

The energy levels needed for the various stages of ionization and excitation are obtained by isoelectronic interpolation. Following Layzer,[26] we express the energy, relative to the bare nucleus with charge Z, of a term γ, in a particular configuration r, for an ion with N bound electrons as

$$\frac{E(r,\gamma,N,Z)}{2\ \mathrm{Ry}} = W_2(r)Z^2 + W_1(r,\gamma,N)Z + W_0(r,\gamma,N) + O(Z^{-1}) \ , \tag{42}$$

where

$$W_2(r,N) = -\sum_{i=1}^{N} \frac{1}{2n_i^2} \ . \tag{43}$$

$W_1(r,\gamma,N)$ can be calculated from first-order perturbation theory and $W_0(r,\gamma,N)$ must be evaluated by comparison with experiment. Layzer has calculated the W_1's including interaction within a complex for all terms of the configurations $1s^2 2s^q 2p^t$, with $q \leq 2$ and $t \leq 6$.

A term-averaged W_1, neglecting interactions within a complex, can be expressed as

$$W_1(r,N) = \sum_{\alpha \text{ in } r} q_\alpha(r) \frac{\sigma_\alpha(r)}{n_\alpha^2} \ , \tag{44}$$

where

$$N = \sum_{\alpha \text{ in } r} q_\alpha(r) \ , \tag{45}$$

$$\sigma_\alpha(r) = \sum_{\beta \text{ in } r} [q_\beta(r) - \delta_{\beta\alpha}]\sigma(\alpha,\beta) \ , \tag{46}$$

and

$$\sigma(\alpha,\beta) = \begin{cases} n_\alpha^2\,[\alpha\beta] & (\alpha > \beta) \\ \frac{1}{2}\, n_\alpha^2\,[\alpha\alpha] & (\alpha = \beta) \\ 0 & (\alpha < \beta) \end{cases} . \qquad (47)$$

The symbol α stands for a pair of quantum numbers (n, ℓ) according to the scheme $\alpha(1s) = 1$, $\alpha(2s) = 2$, $\alpha(2p) = 3$, etc.; $q_\alpha(r)$ is the number of α electrons in the configuration r; and the quantity $[\alpha\beta]$ is the two-electron interaction integral.[27] Varsavsky[11] lists the $\sigma(\alpha,\beta)$'s through $\alpha(4p) = 8$.

Let $E(r, f, Z)$ be the energy, relative to the ground state of the neutral atom, of the configuration r in the f^{th} stage of ionization of an element with atomic number Z. Then,

$$\frac{E(r,f,Z)}{2\ \mathrm{Ry}} = [W_2(r, N = Z-f)\ \ W_2(r_0, N = Z-f)]\ Z^2$$
$$+ [W_1(r, N = Z-f) - W_1(r_0, N = Z-f)]\ Z$$
$$+ [W_0(r, N = Z-f) - W_0(r_0, N = Z-f)] + \frac{E_0(r_0, f, Z)}{2\ \mathrm{Ry}} , \qquad (48)$$

where r_0 is the ground term of the ion and $E_0(r_0, f, Z)$ is the energy of r_0 relative to the ground state of the neutral atom.

In these calculations we have allowed as energy levels for each value of N: (1) all configurations in the lowest complex for N electrons with no more than one 3d electron; and (2) all configurations formed by adding one electron, bound by more than 2 ev if it is an $n \geq 4$ electron, to all configurations in the lowest complex for (N-1) electrons with no 3d electrons. The term-averaged W_1's for those configurations covered by Layzer's calculations were used. For configurations with one or more electrons in the n = 3 shell, Eqs. (44), (45), and (46) were used to calculate the W_1's using the $\sigma(\alpha,\beta)$'s of Varsavsky.[11] For configurations with an electron

with $n \geq 4$, shell-averaged energy levels were used. The W_1's for these configurations were calculated using Eq. (44) with shell-averaged σ's.[3] All the W_0's were calculated by fitting to observed energy levels along each isoelectronic sequence obtained from the NBS tables edited by Moore.[28]

The error introduced by using isoelectronic extrapolation to obtain the energy levels is no greater than that introduced by using term-averaged levels.

IX. CALCULATIONS

The calculation is set up so that one need only specify the atomic number Z; the atomic weight A; a set of (Z + 1) energies [the $E_0(r_0, f, Z)$ for f = 0 to Z of Section VIII]; and the relative number of atoms of Z, C_Z, for each element in a given mixture. For a given set of Γ and kT values, the equation of state, monochromatic absorption coefficients, and the various opacities for the mixture are then calculated at each Γ, kT point. The time required to perform the calculation at one Γ, kT point on an IBM-7090, including the preparation on tape for plotting with an SC-4020 of the monochromatic absorption coefficients, is about 10 sec.

The energy and statistical weight for each level and a complete specification of all possible transitions allowed between the levels are calculated, ordered, and placed on tape by a code called AUGEAS. It is not necessary to prepare a tape unless one wants to add an element or change the W_1's or W_0's in AUGEAS. Given an energy-level tape, one need only specify Z and C_Z for each element in the mixture and the Γ, kT values desired in order to carry out the calculation.

AUGEAS contains a table of all allowed configurations with no $n \geq 4$ electrons for $N \leq 14$. For each configuration there is a set of $q_\alpha(r)$'s (α = 1 to 6); a statistical weight Q(r); the quantities $w_2(r)$, $w_1(r)$, and $w_0(r)$; and an indication of whether or not attaching an $n \geq 4$ electron gives an allowed configuration. The quantities $w_i(r)$ are

$$w_2(r) = 2\,[W_2(r) - W_2(r_0)]\ ,$$

$$w_1(r) = -2\,[W_1(r) - W_1(r_0)]\ , \qquad (49)$$

$$w_0(r) = 2\,[W_0(r) - W_0(r_0)]\ ,$$

where

$$E(Z, r) = [w_2(r)Z^2 - w_1(r)Z + w_0(r)]\ Ry + E_0(r_0) \ . \qquad (50)$$

The allowed configurations with one $n \geq 4$ electron are found by adding an electron to the indicated configurations in the basic table. For each stage of ionization f, n equals 4 to n max where n max is the next integer less than $(f + 1)\sqrt{Ry/2}$. The statistical weight for each of these configurations is

$$Q = 2n^2 Q(r) \ , \qquad (51)$$

where r is the configuration to which the electron is added. The energy is

$$E = E(r, Z) - \frac{(Z - \sigma)^2}{n^2}\ Ry \ , \qquad (52)$$

where σ is the screening of the n electron by the configuration r.

For each Z, the energy and statistical weight of each configuration for f = 0 to Z are calculated. All possible transitions are obtained by matching configurations which differ by one in some q_α or differ by not having an $n \geq 4$ electron attached to one of the configurations. The quantum number of the jumping electron, n, and the number of equivalent electrons that can make the jump, m, are obtained for each transition.

The main code, DIAPHANOUS, uses the energy-level tape written by AUGEAS. An outline of the DIAPHANOUS calculation follows.

I. Calculate for each value of f:

A. $t_f = [1 + 3(f + 1)L]^{1/3} - 1$

$$L = 15.051\ \frac{[Z^* + 1]^{3/2}}{(kT)^{3/2}\Gamma]^{1/2}} \ ,$$

and

$$J_f = F_L \times 1.060\ kT\left[\frac{t_f + \frac{t_f^2}{2}}{Z^* + 1}\right] \ .$$

The quantity Z* is an input number on the first pass. It is normally equal to one. F_L is an input factor that allows one to vary the amount of pressure ionization. It is normally equal to one.

B. $$\Delta E_f = \sum_{\nu=0}^{f-1} J_f kT \ ,$$

$$\Delta E_0 = 0 \ .$$

C. $$X_f = 23.179 \frac{f+1}{(kT)^{1/2}} \ .$$

D. $$B_f = F_W \times 4.128 \times 10^3 \frac{(f+1)^3}{\Gamma (kT)^{5/2}} \ .$$

X_f and B_f are used later in VI and VII. F_W is an input factor that allows one to vary the amount of line broadening. It is normally equal to one.

II. Calculate for each energy level i:

A. Set $q_i = 0$ for all $\Delta E_i \leq J_{f_i} kT$ (ΔE_i is the lowest transition energy out of the state i).

B. $$P_i = q_i e^{(\epsilon_i - \bar{\epsilon})} \ ,$$

$$\epsilon_i = f_i \ell n \Gamma - \left(\frac{E_i - \Delta E_{f_i}}{kT} \right) \ ,$$

$\bar{\epsilon}$ = maximum of all ϵ_i .

C. $$P_Z = \sum_{\substack{\text{all i for} \\ \text{element Z}}} P_i \ .$$

D. $$p_i = \frac{C_Z P_i}{P_Z} \ ,$$

$$p_i = 0 \quad \text{if} \quad \frac{C_Z P_i}{P_Z} < 10^{-14} .$$

III. Calculate:

A. $\bar{Z} = \sum_i p_i f_i$.

B. $\overline{Z^2} = \sum_i p_i f_i^2$.

C. $Z^* = \frac{\overline{Z^2}}{\bar{Z}}$.

IV. Repeat I, II, and III one time with Z^* as calculated on the first pass.

V. Calculate:

A. The electron density in number per cubic centimeter,

$$N_e = 6.052 \times 10^{21} \frac{(kT)^{3/2}}{\Gamma} .$$

B. The density in grams per cubic centimeter,

$$\rho = 1.673 \times 10^{-24} \frac{N_e \sum_Z C_Z A_Z}{\bar{Z}} .$$

C. The pressure in bars,

$$P = 1.602 \times 10^{-18} \left(1 + \frac{1}{\bar{Z}}\right) N_e kT .$$

D. The internal energy in ergs per gram,

$$E = \frac{9.56 \times 10^{11}}{\sum_Z C_Z A_Z} \left[\frac{3}{2}(1 + \bar{Z})kT + \sum_i p_i (E_i - \Delta E_{f_i})\right] .$$

E. The velocity corresponding to E, in km/sec,

$$V = 1.414 \times 10^{-5} E^{1/2} .$$

VI. Calculate for each transition j:

A. $u_j = \Delta E_j / kT$.

B. $\phi_j = \frac{m_j}{n_j} p_{i_j} u_j^2$,

$p_{i_j} = p_i$ in the initial state for transition j.

C. $u_j' = u_j - \left(\frac{B_{f_j}}{2\pi} \right)^{2/7}$.

It is assumed that all lines are merged between u_j' and u_j.

D. An effective K edge is introduced for all levels in the ions with $f \leq Z - 4$.

1. $u_K = 10.204 \, Z^2 / kT = u_K'$.

2. $\phi_K = 2 p_K u_K^2$.

3. $p_K = \sum_{f=0}^{Z-4} \sum_{\substack{\text{all } i \\ \text{for each } f}} p_i$,

$p_K = 0$ for $Z < 4$.

4. f_K = integer nearest to $\bar{Z}$.

5. $n_K = 1$.

VII. Calculate:

A. $D_{ff} = 8.750 \times 10^8 \frac{\overline{Z^2}}{[\Gamma (kT)^2 \sum_Z C_Z A_Z]}$.

B. $A_0 = \dfrac{\Gamma kT}{13.605\ \overline{Z^2}}$.

C. $K_S = \dfrac{0.3977 \sum_Z C_Z Z}{\sum_Z C_Z A_Z}$.

D. $\kappa_{Raizer} = 1.15\ D_{ff}$.

VII. In order to calculate κ_R, define a set of points:

$$
\begin{aligned}
u_k &= 0.55 + 0.05\ k && k = 0 \text{ to } 30 \\
&= 2.05 + 0.025(k-30) && = 30 \text{ to } 230 \\
&= 7.05 + 0.05(k-230) && = 230 \text{ to } 330 \\
&= 12.05 + 0.10(k-330) && = 330 \text{ to } 360
\end{aligned}
$$

A. Calculate for each u_k, k = 0 to 360.

1. $$D(u_k) = D_{ff}\ e^{u^0} + A_0[\,E(u_k) + L(u_k)] + K_S \frac{u_k^3}{1 - e^{-u_k}} ,$$

where

$$E(u_k) = \sum_{j=1}^{j_k} \phi_j$$

and j_k is such that $u_{j_k} < u_k < u'_{j_{k+1}}$,

$$L(u_k) = \sum_{j=j_k+1}^{J} C[\phi_j, x_j(u_k), \beta(u_k)]\phi_j \frac{\sinh \beta_j(u_k)}{\cosh \beta_j(u_k) - \cos x_j(u_k)} ,$$

where

$$C(\phi_j, x_j, \beta_j) = 0 \quad \text{if} \begin{cases} x_j \leq (2n_j + 1)\pi \ , \\ \beta_j \geq 2\pi \ , \\ \phi_j \leq 0.05 \sum_{\nu=1}^{j-1} \phi_\nu \ , \end{cases}$$

$$\beta_j = B_{f_j} [(u_j - u_k)^{-1/2}]^7 \ ,$$

$$x_j = X_{f_j} (u_j - u_k)^{-1/2} \ ,$$

and

$$u^0 = \frac{2 - J_{f'} kT}{kT} \ ,$$

$$= 0 \quad \text{if} \ \frac{2 - J_{f'} kT}{kT} < 0 \ ,$$

where f' is the integer nearest to Z* and e^{u^0} is introduced to compensate for the edges between $u = 2/kT$ and $J_{f'}$.

2. $$\frac{dS}{du} = A(u_k) = 3.849 \times 10^{-2} \frac{u_k^7 e^{-u_k}}{[1 - e^{-u_k}]^3} \ .$$

3. $$\Sigma(u_k) = \frac{(u_1 - u_0)}{2} H(u_1) + \sum_{\nu=1}^{k-1} \frac{(u_{\nu+1} - u_{\nu-1})}{2} H(u_\nu)$$

$$+ \frac{(u_k - u_{k-1})}{2} H(u_k) \ ,$$

where

$$H(u_k) = \frac{A(u_k)}{D(u_k)} \ .$$

B. Calculate:

1. $\kappa_R = \dfrac{1}{\Sigma\,(u_{360})}$.

If the last edge occurs before u = 15.05, the remainder of the integral for κ_R is calculated with a series of five-point Gaussian quadratures.

2. $\overline{\mu}(u) = 3.849 \times 10^{-3} \dfrac{\rho u^4 e^{-u}}{\{(1 - e^{-u})^3 [\Sigma\,(u + 0.05) - \Sigma\,(u - 0.05)]\}}$

for u = 0.6 + n/10 (n = 0 to 144). This is the quantity that appears in the output as the absorption coefficient.

3. If any edges occur beyond u = 15, $\mu(u'_j) = \dfrac{[\rho D(u'_j)]}{u'^3_j}$

for all $u'_j > 15$.

IX. In order to obtain κ_P:

A. Calculate for each f:

1. $x_f = 13.605 \dfrac{(f + 1)^2}{kT}$.

2. $r_{n,f} = 2e^{x_f/n^2} \dfrac{x_f}{n^3}$,

for

$$n = 2 \text{ to } n_f\text{max},$$

$n_f$max = the next integer less than $[6.803(f + 1)^2]^{1/2}$.

3. $r_{n_f\text{max}+1,\,f} = e^{x_f/(n_f\text{max}+1)^2} - 1$.

B. Calculate for each transition j:

$$R_j = \sum_{m=n_j+1}^{n_{f_j}\max+1} r_{n,f_j}$$

C. $\kappa_P = 1.54 \times 10^{-1} D_{ff}[e^{u_0} + A_0 \sum_j \phi_j e^{-u_j}(1 + R_j)]$.

X. DISCUSSION OF RESULTS

The numerical results of our calculations are presented in Appendices A and B, which are self-explanatory. The range covered is kT = 1.5 to 34.0 ev; Γ = 20 to 8.5×10^{10}. Within this range the actual values used were chosen so as to give roughly uniform spacing in log T and log ρ. The density range depends on the temperature, but is roughly 10^{-1} to 10^{-12} g/cm^3. The elements we have treated are Z = 1, 4, 6, 7, 13, 14; because the code gets its energy levels isoelectronically, it is immediately applicable to the intervening elements, and indeed to heavier elements provided that the temperature and density are such that virtually no ions may be expected to have more than 14 bound electrons. Thus, for example, iron (Z = 26) satisfies this condition if kT $\ell n\, \Gamma > 355$ ev, which is its thirteenth ionization potential. Provision for any mixture of such elements is also in the code.

Appendix A gives the thermodynamic properties and mean opacities; Appendix B gives the "monochromatic" absorption coefficients. To keep the presentation of the latter within reason, we have divided the range of u into two parts for each value of Z, Γ, and kT. In the first part, linear in u from 0.6 to 15.0, we plot the absorption coefficient $\mu (= \rho\kappa)$, harmonically averaged over intervals $\Delta u = 1/10$. The second part is logarithmic in u from 15 to 1000 and shows the continuous absorption coefficient only. The values of μ are scaled to the minimum values occurring in the regions u = 0 to 15 and u = 15 to 150, respectively, and values more than 1000 times these minima are not plotted. Thus, the values of μ which contribute appreciably to the Rosseland mean are those which are exhibited in most detail. On each page, the pair of graphs appearing for u < 15 were calculated with and without lines, showing the line effect on the "monochromatic" absorption coefficients. All of Appendix B includes the scattering contribution as part of the absorption coefficient.

The mean opacities, with and without lines, of Appendix A show some regularities in behavior which are exemplified (for the Rosseland mean) by Fig. 1. Though Fig. 1 was calculated for CH_2, the pure-carbon or nitrogen results are not qualitatively different. The factor by which lines increase the Rosseland mean opacity, κ_R (or decrease Λ_R), is seen to be correlated with the presence of strong photoelectric edges at $u \sim 5$, the important part of the Rosseland weighting function. Examination of Appendix A shows that this factor can amount to nearly 10 (hydrogen at 2.25 ev, high densities) and typically has a maximum in density (for a fixed temperature). The maximum comes about through a competition between available line strength and line width.

The effect of lines on the Planck mean, though much more dramatic (a factor $\sim 10^3$ at low densities), should actually be regarded as a caution against the indiscriminate use of κ_P in emissivity problems. We recall from Section I that the Planck mean describes the net energy-loss rate of an object which is optically thin at all frequencies, including those of the centers of strong and narrow lines at large values of u; these lines are the ones responsible for the large line factors in the Planck mean, and in actual problems they will often be strongly self-absorbed, invalidating the use of the Planck mean as defined. (The validity condition is more stringent than just requiring the object to be small compared with a Planck mean free path.) Typically, Appendix A indicates a steady increase in the Planck line factor as the density decreases.

The opacities without lines which we give, as mentioned before, have all the absorption edges at their zero-density (unperturbed) positions, so our line factors effectively come partly from the lines whose upper states are engulfed by the continuum due to pressure ionization. We have not attempted to give this part of the line factor separately. Our Planck mean opacities do not include scattering, whereas the Rosseland and monochromatic results do (this is why $\kappa_P < \kappa_R$ in some cases).

The absolute accuracy of our results is not easy to estimate, since

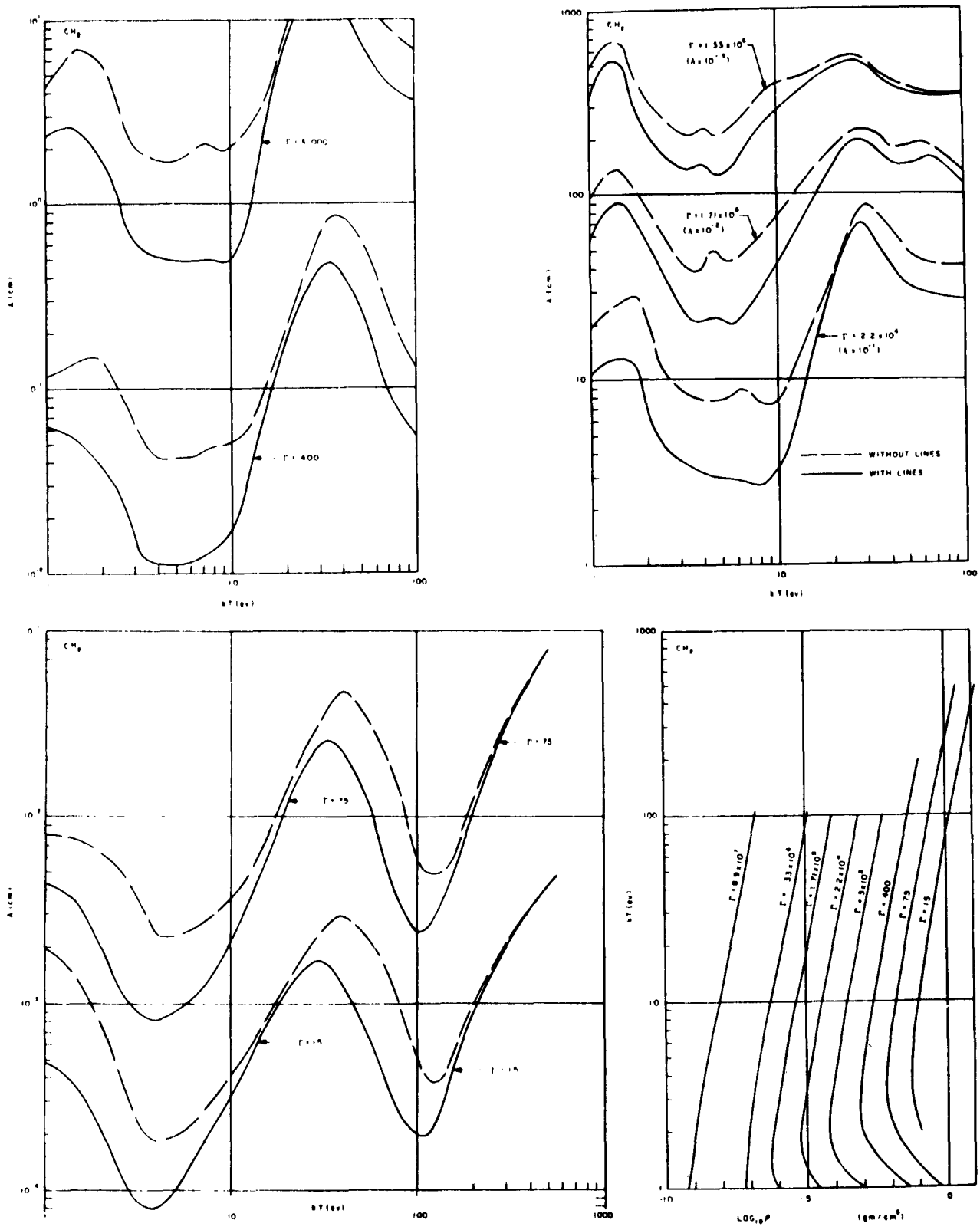

Figure 1

we think it is limited in most cases by the scaled hydrogenic matrix elements used. The strengths of individual edges may be in error by factors of 2 or more, but compensation tends to occur, and seldom is a single edge crucial in the opacity. We can make some statements about the sensitivity to line widths: we have made a number of spot checks in which all line widths were doubled or halved. The effect of either of these operations is to change the Rosseland mean by about 10% when the line factor is about 3, and from the discussion of Section V it follows that the same or less effect should occur if we split each line into two components. A more detailed level scheme (such as distinguishing the separate LS terms of the L-shell configurations) would have as one effect such splitting, generally into several components.

At lower temperatures or higher densities than those used in our calculations, effects which we have not included become important. We may mention degeneracy corrections, energy transport by free electrons, molecules, negative ions, and Rayleigh scattering. On the other hand, our method should be good up to temperatures of several kilovolts, where (at low densities) the equilibrium positron density makes itself felt.[29]

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REFERENCES

1. Chandrasekhar, Subrahmanyan, An Introduction to the Study of Stellar Structure, (reprint), Dover Publications, New York, 1957.
2. Rudkjøbing, M., Pub. Copenhagen Observatory, Vol. 145, 1947.
3. Mayer, H., Los Alamos Scientific Laboratory, Report LA-647, 1948.
4. Eddington, A. S., The Internal Constitution of the Stars, (reprint), Dover Publications, New York, 1959.
5. Raĭzer, Yu. P., "A Simple Method of Calculating the Degree of Ionization and Thermodynamic Functions of a Multiply Ionized Ideal Gas," Soviet Phys. JETP, Vol. 9, 1959, p. 1124.
6. Keller, G., and R. E. Meyerott, The Ionization of Gas Mixtures in Stellar Interiors, Argonne National Laboratory, Report ANL-4771, March, 1952.
7. Keller, G., and R. E. Meyerott, The Ionization of Gas Mixtures in Stellar Interiors II. The Average Number of Electrons Occupying Various Shells, Argonne National Laboratory, Report ANL-4856, July, 1952.
8. Aller, L. H., Astrophysics, Vol. 1, Ronald Press Company, New York, 1953.
9. Unsöld, A., Physik der Sternatmosphären, mit besonderer Berücksichtigung der Sonne, (2d ed.), Springer-Verlag, Berlin, 1955.
10. Schwarzschild, M., Structure and Evolution of the Stars, Princeton University Press, Princeton, N. J., 1958.
11. Varsavsky, C. M., The Calculation of Absolute Line Strengths in Atomic Spectra, Thesis, Harvard University, 1958.
12. Burgess, A., and M. J. Seaton, M. N., Vol. 120, 1960, p. 121.
13. Armstrong, B. H., D. H. Holland, and R. E. Meyerott, Absorption Coefficients of Air from 22,000° to 220,000°, Lockheed Aircraft Corporation, Report LMSD-5135, August 15, 1958.
14. Bernstein, J., and F. J. Dyson, The Continuous Opacity and Equations of State of Light Elements at Low Densities, General Atomic, Report GA-848, July 13, 1959. (Contract AF 18(600)-1812)
15. Raĭzer, Yu. P., "Simple Method for Computing the Mean Range of Radiation in Ionized Gases at High Temperatures," Soviet Phys. JETP, Vol. 10, 1960, p. 769.

16. Armstrong, B. H., Lockheed Aircraft Corporation, Report LMSD-45759, 1959.

17. Elsasser, W. M., Harvard Meteorological Studies No. 6, 1942.

18. Penner, S. S., Quantitative Molecular Spectroscopy and Gas Emissivities, Addison-Wesley Publishing Company, Reading, Mass., 1959.

19. Baranger, M., "Spectral Line Broadening in Plasmas," Chap. 13 in D. R. Bates (ed.), Atomic and Molecular Processes, to be published.

20. Baranger, M., and J. C. Stewart, The Calculation of Line Widths, General Atomic, Report GAMD-927, August 13, 1959. (Contract AF 18(600)-1812)

21. Baranger, M., and J. C. Stewart, The Photon Absorption Coefficient in the Windows between Spectral Lines, General Atomic, Report GAMD-996, September 23, 1959. (Contract AF 18(600)-1812)

22. Griem, Hans R., "Stark Broadening of Higher Hydrogen and Hydrogen-like Lines by Electrons and Ions," Astrophys. J., Vol. 132, 1960, p. 883.

23. Moszkowski, S. A., and R. E. Meyerott, Opacity Calculations for Light Elements and Mixtures, Argonne National Laboratory, Report ANL-4743, October, 1951.

24. Cox, A. N., "Stellar Absorption Coefficients and Opacities," Chap. 2 in G. P. Kuiper (ed.), Stars and Stellar Systems, Vol. 8, to be published.

25. Griem, H. R., M. Baranger, A. C. Kolb, and G. Oertel, "Stark Broadening of Neutral Helium Lines in a Plasma," Phys. Rev., to be published.

26. Layzer, David, "On a Screening Theory of Atomic Spectra," Ann. Phys., Vol. 8, 1959, p. 271.

27. Condon, E. U., and G. H. Shortley, The Theory of Atomic Spectra, The University Press, Cambridge, 1957.

28. Moore, C. E., Atomic Energy Levels as Derived from the Analyses of Optical Spectra, National Bureau of Standards Circular No. 467, 1949.

29. Sampson, D. H., "The Opacity at High Temperatures due to Compton Scattering," Astrophys. J., Vol. 129, 1959, p. 734.

Appendix A

THERMODYNAMIC PROPERTIES AND MEAN OPACITIES

The results of our calculations are summarized in the following tables, grouped by element according to increasing atomic number, for each element grouped according to increasing temperature, and for each temperature listed according to increasing Γ. There are two entries for each value of Γ: the first entry lists the opacities with lines; the second lists them without lines.

The units of the temperature as printed are electron volts. The quantity Γ is listed in the first column. The quantity in the last column, EGAM, is

$$\text{EGAM} = 1 + \frac{P}{\rho E} \ .$$

The internal energy per unit mass, E, is listed under the column labeled ENG. That part of the internal energy due to ionization and excitation is labeled EION. The Rosseland mean opacity is labeled KROS. The Planck mean opacity is labeled KPLK. The numbers are printed in floating-point format; e.g., x.xxxx ±yy is read as $x.xxxx \times 10^{\pm yy}$.

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.32035-01	1.90984+05	2.28607+12	1.16250+11	2.16066+04	1.62842+06	0.007	1.633
2.000+01	1.32035-01	1.90984+05	2.28607+12	1.16250+11	4.49239+03	9.07684+04	0.007	1.633
1.000+02	1.21334-02	1.76949+04	2.43989+12	2.52216+11	2.09159+04	1.60622+06	0.015	1.598
1.000+02	1.21334-02	1.76949+04	2.43989+12	2.52216+11	4.34487+03	8.39762+04	0.015	1.598
5.000+02	8.00012-04	1.20252+03	2.89714+12	6.42302+11	2.01219+04	1.55538+06	0.047	1.519
5.000+02	8.00012-04	1.20252+03	2.89714+12	6.42302+11	4.20735+03	8.13178+04	0.047	1.519
2.500+03	4.70058-05	7.82032+01	4.55905+12	2.06335+12	1.72059+04	1.37303+06	0.158	1.365
2.500+03	4.70058-05	7.82032+01	4.55905+12	2.06335+12	3.71421+03	7.17845+04	0.158	1.365
1.250+04	3.30606-06	6.98603+00	5.94184+12	5.81738+12	9.92881+03	8.97015+05	0.450	1.233
1.250+04	3.30606-06	6.98603+00	8.94184+12	5.81738+12	2.42684+03	4.68975+04	0.450	1.233
6.250+04	3.75633-07	9.67011-01	1.41244+13	1.02627+13	2.84612+03	3.38810+05	0.792	1.182
6.250+04	3.75633-07	9.67011-01	1.41244+13	1.02627+13	9.17189+02	1.77136+04	0.792	1.182
3.400+05	5.74389-08	1.61082-01	1.65769+13	1.23700+13	4.68536+02	7.75498+04	0.952	1.169
3.400+05	5.74389-08	1.61082-01	1.65769+13	1.23700+13	2.10618+02	4.05444+03	0.952	1.169
2.000+06	9.78061-09	2.68323-02	1.71872+13	1.28964+13	6.34145+01	1.39471+04	0.991	1.166
2.000+06	9.78061-09	2.68323-02	1.71872+13	1.28964+13	3.85997+01	7.29178+02	0.991	1.166
1.300+07	1.43274-09	4.11307-03	1.73062+13	1.29998+13	8.66624+00	2.17661+03	0.999	1.166
1.300+07	1.43274-09	4.11307-03	1.73062+13	1.29998+13	6.72825+00	1.13797+02	0.999	1.166
1.000+08	1.86040-10	5.34389-04	1.73279+13	1.30190+13	1.58676+00	2.84120+02	1.000	1.166
1.000+08	1.86040-10	5.34389-04	1.73279+13	1.30190+13	1.46762+00	1.48543+01	1.000	1.166
8.500+08	2.18837-11	6.28644-05	1.73318+13	1.30226+13	6.17918-01	3.34675+01	1.000	1.166
8.500+08	2.18837-11	6.28644-05	1.73318+13	1.30226+13	6.06847-01	1.74974+00	1.000	1.166
8.000+09	2.32511-12	6.67929-06	1.73326+13	1.30234+13	4.45405-01	3.55736+00	1.000	1.166
8.000+09	2.32511-12	6.67929-06	1.73326+13	1.30234+13	4.43864-01	1.85985-01	1.000	1.166
8.500+10	2.18833-13	6.28638-07	1.73329+13	1.30236+13	4.13558-01	3.34854-01	1.000	1.166
8.500+10	2.18833-13	6.28638-07	1.73329+13	1.30236+13	4.13505-01	1.75068-02	1.000	1.166

HYLA... EN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BAR...)	EMS(ERGS/GM)	EION(ERGS/GM)	KRAD(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.92389-02	4.51316+...	4.76341+12	1.24440+12	3.52366+05	3.27719+06	0.089	1.492
2.000+01	1.92389-02	4.51316+...	4.76341+12	1.24440+12	3.72183+04	4.92909+05	0.089	1.492
1.000+02	1.70505-03	4.40979+...	4.46934+12	2.59013+12	2.98263+05	2.83092+06	0.200	1.400
1.000+02	1.70505-03	4.40979+...	4.46934+12	2.59013+12	2.71719+04	3.87666+05	0.200	1.400
5.000+02	1.50936-04	4.72441+...	1.06429+13	5.94749+12	1.74035+05	1.87323+06	0.453	1.294
5.000+02	1.50936-04	4.72441+...	1.06429+13	5.94749+12	1.45779+04	2.62188+05	0.453	1.294
2.500+03	1.77284-05	6.76456+...	1.56088+13	9.68497+12	5.12804+04	7.83913+05	0.771	1.244
2.500+03	1.77284-05	6.76456+...	1.56088+13	9.68497+12	6.19353+03	1.09721+05	0.771	1.244
1.250+04	2.91465-06	1.21695+...	1.93268+13	1.20632+13	1.16825+04	2.12470+05	0.938	1.228
1.250+04	2.91465-06	1.21695+...	1.93268+13	1.20632+13	2.22140+03	2.97366+04	0.938	1.228
6.250+04	5.54385-07	2.37241+...	1.91751+13	1.27557+13	1.53933+03	4.71472+04	0.986	1.223
6.250+04	5.54385-07	2.37241+...	1.91751+13	1.27557+13	4.93620+02	6.59902+03	0.986	1.223
3.400+05	1.00770-07	4.33851-...	1.94026+13	1.29472+13	1.97756+02	8.99942+03	0.997	1.222
3.400+05	1.00770-07	4.33851-...	1.94026+13	1.29472+13	9.49366+01	1.25961+03	0.997	1.222
2.000+06	1.70937-08	7.36404-...	1.94620+13	1.29996+13	2.63966+01	1.55183+03	1.000	1.221
2.000+06	1.70937-08	7.36404-...	1.94620+13	1.29996+13	1.70929+01	2.17203+02	1.000	1.221
1.300+07	2.62879-09	1.13271-...	1.94792+13	1.30155+13	4.10763+00	2.40084+02	1.000	1.221
1.300+07	2.62879-09	1.13271-...	1.94792+13	1.30155+13	3.63743+00	3.36036+01	1.000	1.221
1.000+08	3.41722-10	1.47248-...	1.94848+13	1.30209+13	1.08840+00	3.12605+01	1.000	1.221
1.000+08	3.41722-10	1.47248-...	1.94848+13	1.30209+13	1.02190+00	4.37821+00	1.000	1.221
8.500+08	4.02022-11	1.73232-...	1.94867+13	1.30227+13	5.95676-01	3.68306+00	1.000	1.221
8.500+08	4.02022-11	1.73232-...	1.94867+13	1.30227+13	5.87844-01	5.15503-01	1.000	1.221
8.000+09	4.27148-12	1.84059-...	1.94873+13	1.30233+13	4.52671-01	3.91437-01	1.000	1.221
8.000+09	4.27148-12	1.84059-...	1.94873+13	1.30233+13	4.51307-01	5.47878-02	1.000	1.221
8.500+10	4.02022-13	1.73232-...	1.94875+13	1.30236+13	4.05963-01	3.68446-02	1.000	1.221
8.500+10	4.02022-13	1.73232-...	1.94875+13	1.30236+13	4.05931-01	5.15700-03	1.000	1.221

HYDROGEN 9.2/61-GENERAL ATOMIC

TEMPERATURE = 3.+0[illegible]

GAMMA	RHO(GM/CM3)	P(BAR[illegible])	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	6.63278-03	3.84389+[illegible]4	1.00648+13	3.40544+12	6.74914+05	2.62555+06	0.368	1.442
2.000+01	6.63278-03	3.84389+[illegible]4	1.00648+13	3.40544+12	1.08465+05	7.54100+05	0.368	1.442
1.000+02	1.09192-03	5.58902+[illegible]2	1.48764+13	7.12719+12	4.05134+05	1.44698+06	0.587	1.347
1.000+02	1.09192-03	5.58902+[illegible]2	1.48764+13	7.12719+12	8.13795+04	3.99374+05	0.587	1.347
5.000+02	1.56256-04	9.22047+[illegible]2	1.92197+13	1.03679+13	1.45926+05	5.45168+05	0.812	1.307
5.000+02	1.56256-04	9.22047+[illegible]2	1.92197+13	1.03679+13	3.26919+04	1.52510+05	0.812	1.307
2.500+03	2.67684-05	1.69815+[illegible]2	2.15541+13	1.20377+13	3.40229+04	1.49628+05	0.949	1.294
2.500+03	2.67684-05	1.69815+[illegible]2	2.15541+13	1.20377+13	8.97342+03	4.18580+04	0.949	1.294
1.250+04	5.13801-06	3.32607+[illegible]1	2.23792+13	1.26684+13	5.98821+03	3.38810+04	0.988	1.289
1.250+04	5.13801-06	3.32607+[illegible]1	2.23792+13	1.26684+13	2.03269+03	9.47812+03	0.988	1.289
6.250+04	1.01812-06	6.62128+[illegible]	2.26424+13	1.28866+13	9.40658+02	7.12226+03	0.998	1.287
6.250+04	1.01812-06	6.62128+[illegible]	2.26424+13	1.28866+13	4.28116+02	1.99243+03	0.998	1.287
3.400+05	1.86782-07	1.21593+[illegible]	2.27351+13	1.29696+13	1.37596+02	1.33792+03	1.000	1.286
3.400+05	1.86782-07	1.21593+[illegible]	2.27351+13	1.29696+13	8.12573+01	3.74281+02	1.000	1.286
2.000+06	3.17408-08	2.06669-[illegible]1	2.27696+13	1.30023+13	2.04048+01	2.29569+02	1.000	1.286
2.000+06	3.17408-08	2.06669-[illegible]1	2.27696+13	1.30023+13	1.47772+01	6.42213+01	1.000	1.286
1.300+07	4.88287-09	3.17942-[illegible]2	2.27831+13	1.30154+13	3.54845+00	3.54565+01	1.000	1.286
1.300+07	4.88287-09	3.17942-[illegible]2	2.27831+13	1.30154+13	3.05096+00	9.91888+00	1.000	1.286
1.000+08	6.34766-10	4.13322-[illegible]3	2.27884+13	1.30207+13	1.02317+00	4.61675+00	1.000	1.286
1.000+08	6.34766-10	4.13322-[illegible]3	2.27884+13	1.30207+13	9.74834-01	1.29152+00	1.000	1.286
6.500+08	7.46783-11	4.86261-[illegible]4	2.27904+13	1.30226+13	5.22477-01	5.43469-01	1.000	1.286
8.500+08	7.46783-11	4.86261-[illegible]4	2.27904+13	1.30226+13	5.17613-01	1.52034-01	1.000	1.286
3.000+09	7.93457-12	5.16653-[illegible]5	2.27911+13	1.30233+13	4.15064-01	5.77556-02	1.000	1.286
8.000+09	7.93457-12	5.16653-[illegible]5	2.27911+13	1.30233+13	4.14742-01	1.61570-02	1.000	1.286
8.500+10	7.46783-13	4.86261-[illegible]6	2.27913+13	1.30235+13	4.00502-01	5.43620-03	1.000	1.286
8.500+10	7.46783-13	4.86261-[illegible]6	2.27913+13	1.30235+13	4.00474-01	1.52076-03	1.000	1.286

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.06010-03	7.04772+04	1.70321+13	5.36312+12	1.87621+05	1.18322+06	0.625	1.457
2.000+01	9.06010-03	7.04772+04	1.70321+13	5.36312+12	1.44912+05	5.30664+05	0.625	1.457
1.000+02	1.45164-03	1.23700+04	2.18410+13	9.05813+12	7.29158+04	4.59279+05	0.780	1.390
1.000+02	1.45164-03	1.23700+04	2.18410+13	9.05813+12	5.83320+04	1.99353+05	0.780	1.390
5.000+02	2.51256-04	2.28693+03	2.49231+13	1.12693+13	2.13820+04	1.35816+05	0.901	1.365
5.000+02	2.51256-04	2.28693+03	2.49231+13	1.12693+13	1.73370+04	5.90781+04	0.901	1.365
2.500+03	4.64103-05	4.38997+02	2.64773+13	1.22879+13	5.18592+03	3.34274+04	0.976	1.357
2.500+03	4.64103-05	4.38997+02	2.64773+13	1.22879+13	4.26775+03	1.45404+04	0.976	1.357
1.250+04	9.10428-06	8.69482+01	2.70406+13	1.27143+13	1.09879+03	7.27024+03	0.995	1.353
1.250+04	9.10428-06	8.69482+01	2.70406+13	1.27143+13	9.28963+02	3.16244+03	0.995	1.353
6.250+04	1.81320-06	1.73530+01	2.72466+13	1.28901+13	2.20432+02	1.50617+03	0.999	1.351
6.250+04	1.81320-06	1.73530+01	2.72466+13	1.28901+13	1.93214+02	6.55161+02	0.999	1.351
3.400+05	3.33012-07	3.18847+00	2.73303+13	1.29674+13	4.05291+01	2.81276+02	1.000	1.350
3.400+05	3.33012-07	3.18847+00	2.73303+13	1.29674+13	3.68467+01	1.22351+02	1.000	1.350
1.000+06	5.66024-08	5.41993-01	2.73647+13	1.30007+13	7.46400+00	4.81465+01	1.000	1.350
2.000+06	5.66024-08	5.41993-01	2.73647+13	1.30007+13	7.01417+00	2.09430+01	1.000	1.350
1.300+07	8.70781-09	8.33824-02	2.73789+13	1.30147+13	1.69283+00	7.42876+00	1.000	1.350
1.300+07	8.70781-09	8.33824-02	2.73789+13	1.30147+13	1.64210+00	3.23139+00	1.000	1.350
1.000+08	1.13201-09	1.08397-02	2.73847+13	1.30204+13	6.32194-01	9.66897-01	1.000	1.350
1.000+08	1.13201-09	1.08397-02	2.73847+13	1.30204+13	6.32390-01	4.20585-01	1.000	1.350
8.500+08	1.33178-10	1.27526-03	2.73869+13	1.30225+13	4.35623-01	1.13803-01	1.000	1.350
8.500+08	1.33178-10	1.27526-03	2.73869+13	1.30225+13	4.34944-01	4.95026-02	1.000	1.350
8.000+09	1.41501-11	1.35496-04	2.73876+13	1.30233+13	4.03041-01	1.20935-02	1.000	1.350
8.000+09	1.41501-11	1.35496-04	2.73876+13	1.30233+13	4.03030-01	5.26047-03	1.000	1.350
8.500+10	1.33178-12	1.27526-05	2.73879+13	1.30235+13	3.99319-01	1.13827-03	1.000	1.350
8.500+10	1.33178-12	1.27526-05	2.73879+13	1.30235+13	3.99318-01	4.95129-04	1.000	1.350

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 7.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.24280-02	1.46150+05	2.36095+13	5.96880+12	4.75769+04	4.97996+05	0.754	1.498
2.000+01	1.24280-02	1.46150+05	2.36095+13	5.96880+12	4.66220+04	2.91682+05	0.754	1.498
1.000+02	2.21426-03	2.74112+04	2.80551+13	9.48484+12	1.54328+04	1.60496+05	0.847	1.441
1.000+02	2.21426-03	2.74112+04	2.80551+13	9.48484+12	1.51427+04	9.15473+04	0.847	1.441
5.000+02	4.05285-04	5.23043+03	3.07522+13	1.13926+13	4.11575+03	4.27949+04	0.925	1.420
5.000+02	4.05285-04	5.23043+03	3.07522+13	1.13926+13	4.04097+03	2.43363+04	0.925	1.420
2.500+03	7.63494-05	1.01453+03	3.22297+13	1.22965+13	9.69181+02	1.00809+04	0.982	1.412
2.500+03	7.63494-05	1.01453+03	3.22297+13	1.22965+13	9.52874+02	5.73275+03	0.982	1.412
1.250+04	1.50579-05	2.01486+02	3.27757+13	1.27034+13	2.07452+02	2.15263+03	0.996	1.408
1.250+04	1.50579-05	2.01486+02	3.27757+13	1.27034+13	2.04463+02	1.22414+03	0.996	1.408
6.250+04	3.00260-06	4.02369+01	3.29641+13	1.28818+13	4.34997+01	4.42505+02	0.999	1.406
6.250+04	3.00260-06	4.02369+01	3.29641+13	1.28818+13	4.30059+01	2.51640+02	0.999	1.406
3.400+05	5.51601-07	7.39416+00	3.30717+13	1.29631+13	8.97284+00	8.23485+01	1.000	1.405
3.400+05	5.51601-07	7.39416+00	3.30717+13	1.29631+13	8.90042+00	4.68293+01	1.000	1.405
2.000+06	9.37611-08	1.25693+00	3.31085+13	1.29988+13	2.21959+00	1.40742+01	1.000	1.405
2.000+06	9.37611-08	1.25693+00	3.31085+13	1.29988+13	2.20718+00	8.00362+00	1.000	1.405
1.300+07	1.44245-08	1.93372-01	3.31239+13	1.30139+13	8.17086-01	2.17017+00	1.000	1.405
1.300+07	1.44245-08	1.93372-01	3.31239+13	1.30139+13	8.14814-01	1.23412+00	1.000	1.405
1.000+08	1.87518-09	2.51383-02	3.31302+13	1.30201+13	4.81183-01	2.82385-01	1.000	1.405
1.000+08	1.87518-09	2.51383-02	3.31302+13	1.30201+13	4.81112-01	1.60585-01	1.000	1.405
8.500+08	2.20609-10	2.95745-03	3.31325+13	1.30224+13	4.10650-01	3.32332-02	1.000	1.405
8.500+08	2.20609-10	2.95745-03	3.31325+13	1.30224+13	4.10649-01	1.88988-02	1.000	1.405
8.000+09	2.34397-11	3.14229-04	3.31333+13	1.30233+13	4.00220-01	3.53146-03	1.000	1.405
8.000+09	2.34397-11	3.14229-04	3.31333+13	1.30233+13	4.00220-01	2.00824-03	1.000	1.405
8.500+10	2.20609-12	2.95745-05	3.31336+13	1.30235+13	3.99051-01	3.32386-04	1.000	1.405
8.500+10	2.20609-12	2.95745-05	3.31336+13	1.30235+13	3.99051-01	1.89019-04	1.000	1.405

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 10.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.93725-02	3.38799+05	3.21097+13	5.87501+12	1.25755+04	1.93139+05	0.826	1.545
2.000+01	1.93725-02	3.38799+05	3.21097+13	5.87501+12	1.25555+04	1.37310+05	0.826	1.545
1.000+02	3.64467-03	6.55591+04	3.64423+13	9.45905+12	3.60447+03	5.47549+04	0.878	1.494
1.000+02	3.64467-03	6.55591+04	3.64423+13	9.45905+12	3.59874+03	3.81528+04	0.878	1.494
5.000+02	6.61172-04	1.24630+04	3.96078+13	1.13313+13	9.23065+02	1.38398+04	0.969	1.476
5.000+02	6.61172-04	1.24630+04	3.96078+13	1.13313+13	9.21494+02	9.53919+03	0.969	1.476
2.500+03	1.29971-04	2.47092+03	4.07718+13	1.22530+13	2.06951+02	3.11268+03	0.985	1.466
2.500+03	1.29971-04	2.47092+03	4.07718+13	1.22530+13	2.06642+02	2.15776+03	0.985	1.466
1.250+04	2.56935-05	4.91305+02	4.13632+13	1.26788+13	4.45972+01	6.55771+02	0.997	1.462
1.250+04	2.56935-05	4.91305+02	4.13632+13	1.26788+13	4.45384+01	4.54590+02	0.997	1.462
6.250+04	5.12611-06	9.81404+01	4.15892+13	1.28696+13	1.00298+01	1.33992+02	0.999	1.460
6.250+04	5.12611-06	9.81404+01	4.15892+13	1.28696+13	1.00184+01	9.28853+01	0.999	1.460
3.400+05	9.41817-07	1.80359+01	4.16846+13	1.29577+13	2.58932+00	2.48658+01	1.000	1.459
3.400+05	9.41817-07	1.80359+01	4.16846+13	1.29577+13	2.58642+00	1.72373+01	1.000	1.459
2.000+06	1.60093-07	3.06595+00	4.17248+13	1.29965+13	9.57227-01	4.24457+00	1.000	1.459
2.000+06	1.60093-07	3.06595+00	4.17248+13	1.29965+13	9.55928-01	2.94240+00	1.000	1.459
1.300+07	2.46293-08	4.71681-01	4.17416+13	1.30130+13	5.41718-01	6.54145-01	1.000	1.459
1.300+07	2.46293-08	4.71681-01	4.17416+13	1.30130+13	5.40789-01	4.53462-01	1.000	1.459
1.000+08	3.20181-09	6.13185-02	4.17484+13	1.30198+13	4.26323-01	8.50995-02	1.000	1.459
1.000+08	3.20181-09	6.13185-02	4.17484+13	1.30198+13	4.25950-01	5.89922-02	1.000	1.459
8.500+08	3.76683-10	7.21394-03	4.17510+13	1.30223+13	4.02539-01	1.00144-02	1.000	1.459
8.500+08	3.76683-10	7.21394-03	4.17510+13	1.30223+13	4.02529-01	6.94209-03	1.000	1.459
8.000+09	4.00226-11	7.66481-04	4.17518+13	1.30232+13	3.99319-01	1.06412-03	1.000	1.459
8.000+09	4.00226-11	7.66481-04	4.17518+13	1.30232+13	3.99318-01	7.37665-04	1.000	1.459
8.500+10	3.76683-12	7.21394-05	4.17521+13	1.30235+13	3.98965-01	1.00156-04	1.000	1.459
8.500+10	3.76683-12	7.21394-05	4.17521+13	1.30235+13	3.98965-01	6.94295-05	1.000	1.459

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 15.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/CM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.39010-02	9.09368+05	4.55127+13	5.27374+12	3.29456+03	6.71267+04	0.868	1.589
2.000+01	3.39010-02	9.09368+05	4.55127+13	5.27374+12	3.29424+03	5.50153+04	0.868	1.589
1.000+02	6.10992-03	1.72246+05	5.14294+13	9.13991+12	8.76314+02	1.73491+04	0.963	1.548
1.000+02	6.10992-03	1.72246+05	5.14294+13	9.13991+12	8.76208+02	1.39397+04	0.963	1.548
5.000+02	1.20770-03	3.42440+04	5.37153+13	1.11804+13	2.07297+02	4.10666+03	0.974	1.528
5.000+02	1.20770-03	3.42440+04	5.37153+13	1.11804+13	2.07275+02	3.29304+03	0.974	1.528
2.500+03	2.38387-04	6.80353+03	5.49908+13	1.21784+13	4.63143+01	9.02471+02	0.987	1.519
2.500+03	2.38387-04	6.80353+03	5.49908+13	1.21764+13	4.63097+01	7.25928+02	0.987	1.519
1.250+04	4.71847-05	1.35363+03	5.56780+13	1.26435+13	1.05705+01	1.88019+02	0.997	1.515
1.250+04	4.71847-05	1.35363+03	5.56780+13	1.26435+13	1.05695+01	1.51238+02	0.997	1.515
6.250+04	9.41654-06	2.70433+02	5.59346+13	1.28535+13	2.88130+00	3.82220+01	0.999	1.513
6.250+04	9.41654-06	2.70433+02	5.59346+13	1.28535+13	2.88096+00	3.07450+01	0.999	1.513
3.400+05	1.73020-06	4.97007+01	5.60415+13	1.29507+13	1.06392+00	7.07624+00	1.000	1.513
3.400+05	1.73020-06	4.97007+01	5.60415+13	1.29507+13	1.06371+00	5.69197+00	1.000	1.513
2.000+06	2.94110-07	8.44877+00	5.60861+13	1.29936+13	5.86031-01	1.20663+00	1.000	1.512
2.000+06	2.94110-07	8.44877+00	5.60861+13	1.29936+13	5.85745-01	9.70589-01	1.000	1.512
1.300+07	4.52470-08	1.29980+00	5.61047+13	1.30119+13	4.46086-01	1.85874-01	1.000	1.512
1.300+07	4.52470-08	1.29980+00	5.61047+13	1.30119+13	4.45542-01	1.49513-01	1.000	1.512
1.000+08	5.88209-09	1.68974-01	5.61123+13	1.30194+13	4.07566-01	2.41764-02	1.000	1.512
1.000+08	5.88209-09	1.68974-01	5.61123+13	1.30194+13	4.07011-01	1.94469-02	1.000	1.512
8.500+08	6.92011-10	1.98793-02	5.61151+13	1.30222+13	4.00033-01	2.84483-03	1.000	1.512
8.500+08	6.92011-10	1.98793-02	5.61151+13	1.30222+13	3.99953-01	2.28832-03	1.000	1.512
8.000+09	7.35261-11	2.11217-03	5.61161+13	1.30232+13	3.99041-01	3.02284-04	1.000	1.512
8.000+09	7.35261-11	2.11217-03	5.61161+13	1.30232+13	3.99040-01	2.43151-04	1.000	1.512
8.500+10	6.92011-12	1.98793-04	5.61164+13	1.30235+13	3.98940-01	2.84509-05	1.000	1.512
8.500+10	6.92011-12	1.98793-04	5.61164+13	1.30235+13	3.98940-01	2.28853-05	1.000	1.512

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	6.08184-02	2.47443+06	6.54001+13	4.36787+12	1.00310+03	2.42028+04	0.888	1.622
2.000+01	6.08184-02	2.47443+06	6.54001+13	4.36787+12	1.00309+03	2.16307+04	0.888	1.622
1.000+02	1.11338-02	4.72698+05	7.23935+13	8.70538+12	2.47511+02	5.84809+03	0.971	1.586
1.000+02	1.11338-02	4.72698+05	7.23935+13	8.70538+12	2.47510+02	5.16979+03	0.971	1.586
5.000+02	2.21241-03	9.42304+04	7.48742+13	1.09827+13	5.69459+01	1.32252+03	0.977	1.569
5.000+02	2.21241-03	9.42304+04	7.48742+13	1.09827+13	5.69456+01	1.16577+03	0.977	1.569
2.500+03	4.37583-04	1.87405+04	7.63336+13	1.20886+13	1.31801+01	2.85201+02	0.988	1.561
2.500+03	4.37583-04	1.87405+04	7.63336+13	1.20886+13	1.31801+01	2.51757+02	0.988	1.561
1.250+04	8.66673-05	3.72981+03	7.71608+13	1.26029+13	3.48872+00	5.89313+01	0.997	1.558
1.250+04	8.66673-05	3.72981+03	7.71608+13	1.26029+13	3.48870+00	5.20207+01	0.997	1.558
6.250+04	1.72986-05	7.45210+02	7.74583+13	1.28354+13	1.26170+00	1.19350+01	0.999	1.556
6.250+04	1.72986-05	7.45210+02	7.74583+13	1.28354+13	1.26169+00	1.05354+01	0.999	1.556
3.400+05	3.17856-06	1.36959+02	7.75793+13	1.29429+13	6.53055-01	2.20570+00	1.000	1.555
3.400+05	3.17856-06	1.36959+02	7.75793+13	1.29429+13	6.53042-01	1.94705+00	1.000	1.555
2.000+06	5.40313-07	2.32820+01	7.76293+13	1.29904+13	4.69991-01	3.75820-01	1.000	1.555
2.000+06	5.40313-07	2.32820+01	7.76293+13	1.29904+13	4.69958-01	3.31750-01	1.000	1.555
1.300+07	8.31240-08	3.58183+00	7.76499+13	1.30106+13	4.15184-01	5.78735-02	1.000	1.555
1.300+07	8.31240-08	3.58183+00	7.76499+13	1.30106+13	4.15115-01	5.10870-02	1.000	1.555
1.000+08	1.08061-08	4.65637-01	7.76583+13	1.30189+13	4.01513-01	7.52648-03	1.000	1.555
1.000+08	1.08061-08	4.65637-01	7.76583+13	1.30189+13	4.01478-01	6.64389-03	1.000	1.555
8.500+08	1.27130-09	5.47809-02	7.76614+13	1.30220+13	3.99245-01	8.85596-04	1.000	1.555
8.500+08	1.27130-09	5.47809-02	7.76614+13	1.30220+13	3.99243-01	7.81747-04	1.000	1.555
8.000+09	1.35076-10	5.82047-03	7.76625+13	1.30231+13	3.98964-01	9.40993-05	1.000	1.555
8.000+09	1.35076-10	5.82047-03	7.76625+13	1.30231+13	3.98964-01	8.30648-05	1.000	1.555
8.500+10	1.27130-11	5.47809-04	7.76629+13	1.30235+13	3.98934-01	8.85656-06	1.000	1.555
8.500+10	1.27130-11	5.47809-04	7.76629+13	1.30235+13	3.98934-01	7.81800-06	1.000	1.555

HYDROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.11572-01	6.90007+06	9.60030+13	3.23144+12	3.35248+02	8.90486+03	0.900	1.644
2.000+01	1.11572-01	6.90007+06	9.60030+13	3.23144+12	3.35248+02	8.38116+03	0.900	1.644
1.000+02	2.05924-02	1.32395+06	1.04617+14	8.17162+12	7.90822+01	2.05572+03	0.975	1.615
1.000+02	2.05924-02	1.32395+06	1.04617+14	8.17162+12	7.90822+01	1.92423+03	0.975	1.615
5.000+02	4.10335-03	2.64297+05	1.07370+14	1.07469+13	1.82613+01	4.49498+02	0.978	1.600
5.000+02	4.10335-03	2.64297+05	1.07370+14	1.07469+13	1.82613+01	4.19849+02	0.978	1.600
2.500+03	8.12460-04	5.25921+04	1.09089+14	1.19850+13	4.67094+00	9.51065+01	0.988	1.593
2.500+03	8.12460-04	5.25921+04	1.09089+14	1.19850+13	4.67094+00	8.88617+01	0.988	1.593
1.250+04	1.60972-04	1.04690+04	1.10116+14	1.25567+13	1.55944+00	1.95302+01	0.998	1.591
1.250+04	1.60972-04	1.04690+04	1.10116+14	1.25567+13	1.55944+00	1.82478+01	0.998	1.591
6.250+04	3.21325-05	2.09177+03	1.10468+14	1.28148+13	7.55735-01	3.94411+00	1.000	1.589
6.250+04	3.21325-05	2.09177+03	1.10468+14	1.28148+13	7.55735-01	3.68513+00	1.000	1.589
3.400+05	5.90437-06	3.84441+02	1.10607+14	1.29341+13	5.05910-01	7.27946-01	1.000	1.589
3.400+05	5.90437-06	3.84441+02	1.10607+14	1.29341+13	5.05910-01	6.80148-01	1.000	1.589
2.000+06	1.00367-06	6.53525+01	1.10663+14	1.29867+13	4.26859-01	1.23959-01	1.000	1.588
2.000+06	1.00367-06	6.53525+01	1.10663+14	1.29867+13	4.26859-01	1.15820-01	1.000	1.588
1.300+07	1.54408-07	1.00542+01	1.10686+14	1.30092+13	4.04555-01	1.90840-02	1.000	1.588
1.300+07	1.54408-07	1.00542+01	1.10686+14	1.30092+13	4.04555-01	1.78310-02	1.000	1.588
1.000+08	2.00730-08	1.30704+00	1.10696+14	1.30184+13	3.99735-01	2.48164-03	1.000	1.588
1.000+08	2.00730-08	1.30704+00	1.10696+14	1.30184+13	3.99735-01	2.31869-03	1.000	1.588
8.500+08	2.36153-09	1.53769-01	1.10699+14	1.30219+13	3.99027-01	2.91988-04	1.000	1.588
8.500+08	2.36153-09	1.53769-01	1.10699+14	1.30219+13	3.99027-01	2.72816-04	1.000	1.588
8.000+09	2.50913-10	1.63380-02	1.10700+14	1.30231+13	3.98942-01	3.10249-05	1.000	1.588
8.000+09	2.50913-10	1.63380-02	1.10700+14	1.30231+13	3.98942-01	2.89877-05	1.000	1.588
8.500+10	2.36153-11	1.53769-03	1.10701+14	1.30235+13	3.98932-01	2.92002-06	1.000	1.588
8.500+10	2.36153-11	1.53769-03	1.10701+14	1.30235+13	3.98932-01	2.72829-06	1.000	1.588

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.69891-02	7.23057+03	6.45860+11	3.52625+11	3.24979+05	3.97580+05	0.227	1.303
2.000+01	3.69891-02	7.23057+03	6.45860+11	3.52625+11	6.81615+04	1.59483+05	0.227	1.303
1.000+02	4.63424-03	1.00570+03	6.44625+11	5.19083+11	2.59964+05	3.07441+05	0.362	1.257
1.000+02	4.63424-03	1.00570+03	6.44625+11	5.19083+11	5.60099+04	1.04259+05	0.362	1.257
5.000+02	5.24159-04	1.36968+02	1.13140+12	7.39419+11	1.47253+05	2.24165+05	0.640	1.231
5.000+02	5.24159-04	1.36968+02	1.13140+12	7.39419+11	3.21840+04	5.95228+04	0.640	1.231
2.500+03	7.61745-05	2.28263+01	1.39344+12	9.43926+11	4.93487+04	1.53629+05	0.880	1.215
2.500+03	7.61745-05	2.28263+01	1.39344+12	9.43926+11	1.17627+04	2.17542+04	0.880	1.215
1.250+04	1.33837-05	4.27025+00	1.55951+12	1.08089+12	1.24262+04	1.22048+05	1.002	1.205
1.250+04	1.33837-05	4.27025+00	1.55951+12	1.08089+12	3.30473+03	6.26698+03	1.002	1.205
6.250+04	2.37264-06	8.05586-01	1.81009+12	1.30076+12	3.02602+03	1.02459+05	1.131	1.188
6.250+04	2.37264-06	8.05586-01	1.81009+12	1.30076+12	9.64942+02	2.03745+03	1.131	1.188
3.400+05	3.40627-07	1.32863-01	2.47364+12	1.88853+12	6.64133+02	6.45121+04	1.448	1.158
3.400+05	3.40627-07	1.32863-01	2.47364+12	1.88853+12	2.85665+02	7.76067+02	1.448	1.158
2.000+06	4.59999-08	2.06892-02	3.26325+12	2.58856+12	1.11147+02	2.07184+04	1.822	1.138
2.000+06	4.59999-08	2.06892-02	3.26325+12	2.58856+12	6.09543+01	2.17695+02	1.822	1.138
1.300+07	6.55514-09	3.09981-03	3.57099+12	2.86162+12	1.45972+01	3.80821+03	1.967	1.132
1.300+07	6.55514-09	3.09981-03	3.57099+12	2.86162+12	9.92781+00	3.89786+01	1.967	1.132
1.000+08	8.40095-10	4.01051-04	3.63200+12	2.91587+12	1.84958+00	5.13084+02	1.996	1.131
1.000+08	8.40095-10	4.01051-04	3.63200+12	2.91587+12	1.51276+00	5.22927+00	1.996	1.131
8.500+08	9.86428-11	4.71519-05	3.64078+12	2.92373+12	3.87734-01	6.07585+01	1.999	1.131
8.500+08	9.86428-11	4.71519-05	3.64078+12	2.92373+12	3.65759-01	6.18890-01	1.999	1.131
8.000+09	1.04784-11	5.00951-06	3.64199+12	2.92482+12	2.08413-01	6.46467+00	2.000	1.131
8.000+09	1.04784-11	5.00951-06	3.64199+12	2.92482+12	2.06071-01	6.58451-02	2.000	1.131
8.500+10	9.86173-13	4.71479-07	3.64217+12	2.92499+12	1.82993-01	6.08662-01	2.000	1.131
8.500+10	9.86173-13	4.71479-07	3.64217+12	2.92499+12	1.82922-01	6.19940-03	2.000	1.131

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.74294-02	1.02380+04	1.17892+12	6.19012+11	2.77029+05	4.42794+05	0.561	1.317
2.000+01	2.74294-02	1.02380+04	1.17892+12	6.19012+11	9.86595+04	1.74015+05	0.561	1.317
1.000+02	4.37733-03	1.78262+03	1.48736+12	8.76469+11	2.44798+05	3.30182+05	0.704	1.274
1.000+02	4.37733-03	1.78262+03	1.48736+12	8.76469+11	5.83404+04	7.97083+04	0.704	1.274
5.000+02	6.39293-04	3.00067+02	1.87059+12	1.16649+12	1.56263+05	2.91828+05	0.964	1.251
5.000+02	6.39293-04	3.00067+02	1.87059+12	1.16649+12	2.71154+04	3.77481+04	0.964	1.251
2.500+03	9.97639-05	5.32976+01	2.36310+12	1.56170+12	5.77096+04	2.29388+05	1.235	1.226
2.500+03	9.97639-05	5.32976+01	2.36310+12	1.56170+12	9.54191+03	1.66675+04	1.235	1.226
1.250+04	1.54245-05	9.57705+00	3.11113+12	2.17972+12	1.32190+04	1.22876+05	1.597	1.200
1.250+04	1.54245-05	9.57705+00	3.11113+12	2.17972+12	2.70805+03	6.69527+03	1.597	1.200
6.250+04	2.63249-06	1.80726+00	3.69995+12	2.67010+12	2.13035+03	3.92761+04	1.872	1.186
6.250+04	2.63249-06	1.80726+00	3.69995+12	2.67010+12	6.45852+02	1.99256+03	1.872	1.186
3.400+05	4.59288-07	3.26331-01	3.92611+12	2.86027+12	2.90970+02	8.50325+03	1.972	1.181
3.400+05	4.59288-07	3.26331-01	3.92611+12	2.86027+12	1.28502+02	4.24249+02	1.972	1.181
2.000+06	7.71888-08	5.52635-02	3.98310+12	2.90910+12	3.84687+01	1.52032+03	1.995	1.180
2.000+06	7.71888-08	5.52635-02	3.98310+12	2.90910+12	2.28135+01	7.56028+01	1.995	1.180
1.300+07	1.18504-08	8.49614-03	3.99623+12	2.92074+12	5.13102+00	2.37799+02	1.999	1.179
1.300+07	1.18504-08	8.49614-03	3.99623+12	2.92074+12	3.80880+00	1.18184+01	1.999	1.179
1.000+08	1.54003-09	1.10437-03	3.99952+12	2.92378+12	8.42608-01	3.10973+01	2.000	1.179
1.000+08	1.54003-09	1.10437-03	3.99952+12	2.92378+12	7.33626-01	1.54537+00	2.000	1.179
8.500+08	1.81172-10	1.29924-04	4.00041+12	2.92464+12	2.90862-01	3.66602+00	2.000	1.179
8.500+08	1.81172-10	1.29924-04	4.00041+12	2.92464+12	2.83004-01	1.82179-01	2.000	1.179
8.000+09	1.92494-11	1.38044-05	4.00068+12	2.92491+12	1.98427-01	3.89790-01	2.000	1.179
8.000+09	1.92494-11	1.38044-05	4.00068+12	2.92491+12	1.97957-01	1.93702-02	2.000	1.179
8.500+10	1.81171-12	1.29924-06	4.00076+12	2.92499+12	1.79575-01	3.66947-02	2.000	1.179
8.500+10	1.81171-12	1.29924-06	4.00076+12	2.92499+12	1.79530-01	1.82350-03	2.000	1.179

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 3.40_0

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.30069-02	2.22559+04	1.83329+12	8.21801+11	9.31542+04	3.54654+05	0.867	1.368
2.000+01	3.30069-02	2.22559+04	1.83329+12	8.21801+11	5.96087+04	1.30853+05	0.867	1.368
1.000+02	5.16792-03	3.93339+03	2.44497+12	1.30323+12	7.93106+04	2.60370+05	1.107	1.311
1.000+02	5.16792-03	3.93339+03	2.44497+12	1.30323+12	3.75561+04	5.89656+04	1.107	1.311
5.000+02	8.12825-04	7.06934+02	3.21959+12	1.91492+12	4.70942+04	1.56649+05	1.408	1.270
5.000+02	8.12825-04	7.06934+02	3.21959+12	1.91492+12	1.74168+04	2.72211+04	1.408	1.270
2.500+03	1.30568-04	1.29829+02	3.92772+12	2.43612+12	1.78957+04	6.85689+04	1.753	1.253
2.500+03	1.30568-04	1.29829+02	3.92772+12	2.43612+12	5.86870+03	1.06416+04	1.753	1.253
1.250+04	2.37100-05	2.50975+01	4.33073+12	2.74265+12	3.99734+03	1.95400+04	1.930	1.244
1.250+04	2.37100-05	2.50975+01	4.33073+12	2.74265+12	1.51261+03	2.93839+03	1.930	1.244
6.250+04	4.61366-06	4.97314+00	4.47671+12	2.85973+12	7.16360+02	4.48308+03	1.984	1.241
6.250+04	4.61366-06	4.97314+00	4.47671+12	2.85973+12	3.38453+02	6.69199+02	1.984	1.241
3.400+05	8.42649-07	9.12211-01	4.52506+12	2.90113+12	1.12338+02	8.71734+02	1.997	1.239
3.400+05	8.42649-07	9.12211-01	4.52506+12	2.90113+12	6.57036+01	1.29915+02	1.997	1.239
2.000+06	1.43067-07	1.55010-01	4.54130+12	2.91599+12	1.64905+01	1.51681+02	1.999	1.239
2.000+06	1.43067-07	1.55010-01	4.54130+12	2.91599+12	1.16930+01	2.25980+01	1.999	1.239
1.300+07	2.20053-08	2.38458-02	4.54719+12	2.92162+12	2.48727+00	2.35619+01	2.000	1.238
1.300+07	2.20053-08	2.38458-02	4.54719+12	2.92162+12	2.08021+00	3.51014+00	2.000	1.238
1.000+08	2.86059-09	3.09992-03	4.54943+12	2.92382+12	5.14024-01	3.07514+00	2.000	1.238
1.000+08	2.86059-09	3.09992-03	4.54943+12	2.92382+12	4.90103-01	4.58115-01	2.000	1.238
8.500+08	3.36538-10	3.64696-04	4.55023+12	2.92462+12	2.27700-01	3.62309-01	2.000	1.238
8.500+08	3.36538-10	3.64696-04	4.55023+12	2.92462+12	2.25926-01	5.39742-02	2.000	1.238
8.000+09	3.57571-11	3.87490-05	4.55050+12	2.92490+12	1.82900-01	3.85170-02	2.000	1.238
8.000+09	3.57571-11	3.87490-05	4.55050+12	2.92490+12	1.82769-01	5.73769-03	2.000	1.238
8.500+10	3.36538-12	3.64696-06	4.55060+12	2.92499+12	1.77592-01	3.62771-03	2.000	1.238
8.500+10	3.36538-12	3.64696-06	4.55060+12	2.92499+12	1.77587-01	5.40111-04	2.000	1.238

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	4.35036-02	5.02088+04	2.69444+12	9.63142+11	2.47099+04	2.00701+05	1.173	1.428
2.000+01	4.35036-02	5.02088+04	2.69444+12	9.63142+11	2.27349+04	9.27186+04	1.173	1.428
1.000+02	7.02991-03	9.15421+03	3.62532+12	1.67193+12	1.47647+04	1.09835+05	1.451	1.359
1.000+02	7.02991-03	9.15421+03	3.62532+12	1.67193+12	1.30556+04	3.81668+04	1.451	1.359
5.000+02	1.19260-03	1.71749+03	4.41476+12	2.25444+12	6.42517+03	4.63230+04	1.711	1.326
5.000+02	1.19260-03	1.71749+03	4.41476+12	2.25444+12	5.53630+03	1.43355+04	1.711	1.326
2.500+03	2.15612-04	3.31329+02	4.92929+12	2.62410+12	1.94070+03	1.42085+04	1.893	1.312
2.500+03	2.15612-04	3.31329+02	4.92929+12	2.62410+12	1.66489+03	4.26409+03	1.893	1.312
1.250+04	4.13537-05	6.53263+01	5.16694+12	2.79725+12	4.67688+02	3.49289+03	1.974	1.306
1.250+04	4.13537-05	6.53263+01	5.16694+12	2.79725+12	4.07462+02	1.03875+03	1.974	1.306
6.250+04	8.18561-06	1.30200+01	5.25630+12	2.87026+12	9.97924+01	7.60948+02	1.994	1.303
6.250+04	8.18561-06	1.30200+01	5.25630+12	2.87026+12	8.89983+01	2.25823+02	1.994	1.303
3.400+05	1.50123-06	2.39154+00	5.29180+12	2.90207+12	1.89220+01	1.45358+02	1.999	1.301
3.400+05	1.50123-06	2.39154+00	5.29180+12	2.90207+12	1.73355+01	4.31060+01	1.999	1.301
2.000+06	2.55094-07	4.06501-01	5.30611+12	2.91566+12	3.51829+00	2.51683+01	2.000	1.300
2.000+06	2.55094-07	4.06501-01	5.30611+12	2.91566+12	3.31171+00	7.45054+00	2.000	1.300
1.300+07	3.92421-08	6.25369-02	5.31196+12	2.92139+12	7.81532-01	3.94273+00	2.000	1.300
1.300+07	3.92421-08	6.25369-02	5.31196+12	2.92139+12	7.53901-01	1.15440+00	2.000	1.300
1.000+08	5.10139-09	8.12975-03	5.31446+12	2.92385+12	2.78486-01	5.58469-01	2.000	1.300
1.000+08	5.10139-09	8.12975-03	5.31446+12	2.92385+12	2.74927-01	1.50532-01	2.000	1.300
8.500+08	6.00143-10	9.56431-04	5.31644+12	2.92578+12	1.91119-01	1.10818-01	2.000	1.300
8.500+08	6.00143-10	9.56431-04	5.31644+12	2.92578+12	1.90338-01	1.77485-02	2.000	1.300
8.000+09	6.37454-11	1.01610-04	5.32736+12	2.93621+12	1.78539-01	5.73783-02	2.001	1.299
8.000+09	6.37454-11	1.01610-04	5.32736+12	2.93621+12	1.78500-01	1.90640-03	2.001	1.299
8.500+10	5.97978-12	9.55281-06	5.44094+12	3.04452+12	1.77185-01	5.12864-02	2.007	1.294
8.500+10	5.97978-12	9.55281-06	5.44094+12	3.04452+12	1.77184-01	1.99471-04	2.007	1.294

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 7.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	5.61769-02	1.04624+05	3.80380+12	1.01001+12	7.83916+03	1.02269+05	1.504	1.490
2.000+01	5.61769-02	1.04624+05	3.80380+12	1.01001+12	7.66358+03	5.89847+04	1.504	1.490
1.000+02	1.04350-02	2.03296+04	4.70201+12	1.77950+12	3.49237+03	4.24285+04	1.620	1.414
1.000+02	1.04350-02	2.03296+04	4.70201+12	1.77950+12	3.41332+03	2.08664+04	1.620	1.414
5.000+02	1.86824-03	3.90324+03	5.46391+12	2.32963+12	1.23226+03	1.45415+04	1.809	1.382
5.000+02	1.86824-03	3.90324+03	5.46391+12	2.32963+12	1.20288+03	6.65937+03	1.809	1.382
2.500+03	3.50687-04	7.63571+02	5.91084+12	2.64460+12	3.35611+02	3.97420+03	1.928	1.368
2.500+03	3.50687-04	7.63571+02	5.91084+12	2.64460+12	3.27894+02	1.78068+03	1.928	1.368
1.250+04	6.81790-05	1.51258+02	6.12619+12	2.79818+12	7.87493+01	9.41252+02	1.983	1.362
1.250+04	6.81790-05	1.51258+02	6.12619+12	2.79818+12	7.71043+01	4.14576+02	1.983	1.362
6.250+04	1.35449-05	3.01840+01	6.21154+12	2.86868+12	1.72158+01	2.13304+02	1.996	1.359
6.250+04	1.35449-05	3.01840+01	6.21154+12	2.86868+12	1.69130+01	8.84839+01	1.996	1.359
3.400+05	2.48603-06	5.54567+00	6.25011+12	2.90361+12	3.66122+00	5.30723+01	2.000	1.357
3.400+05	2.48603-06	5.54567+00	6.25011+12	2.90361+12	3.61524+00	1.67927+01	2.000	1.357
2.000+06	4.22305-07	9.42525-01	6.28177+12	2.93377+12	9.48600-01	2.20806+01	2.001	1.355
2.000+06	4.22305-07	9.42525-01	6.28177+12	2.93377+12	9.39900-01	2.93616+00	2.001	1.355
1.300+07	6.47648-08	1.44851-01	6.39697+12	3.04190+12	3.70008-01	1.65360+01	2.007	1.350
1.300+07	6.47648-08	1.44851-01	6.39697+12	3.04190+12	3.66313-01	4.99165-01	2.007	1.350
1.000+08	8.22823-09	1.86885-02	7.21371+12	3.80660+12	2.22734-01	1.49431+01	2.054	1.315
1.000+08	8.22823-09	1.86885-02	7.21371+12	3.80660+12	2.21428-01	1.08844-01	2.054	1.315
8.500+08	8.54642-10	2.11432-03	1.19730+13	8.26189+12	1.89730-01	1.05869+01	2.327	1.207
8.500+08	8.54642-10	2.11432-03	1.19730+13	8.26189+12	1.89358-01	4.29690-02	2.327	1.207
8.000+09	7.49077-11	2.12823-04	2.05962+13	1.63343+13	1.79744-01	2.88883+00	2.820	1.138
8.000+09	7.49077-11	2.12823-04	2.05962+13	1.63343+13	1.79695-01	1.03768-02	2.820	1.138
8.500+10	6.66983-12	1.97476-05	2.34127+13	1.89713+13	1.77336-01	4.02776-01	2.981	1.126
8.500+10	6.66983-12	1.97476-05	2.34127+13	1.89713+13	1.77334-01	1.15732-03	2.981	1.126

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 10.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	8.93824-02	2.48258+05	5.04808+12	8.81591+11	3.03818+03	4.54998+04	1.614	1.550
2.000+01	8.93824-02	2.48258+05	5.04808+12	8.81591+11	2.46765+03	3.18921+04	1.614	1.550
1.000+02	1.68836-02	4.85967+04	6.07889+12	1.76110+12	1.10328+03	1.60305+04	1.709	1.473
1.000+02	1.68836-02	4.85967+04	6.07889+12	1.76110+12	8.99608+02	9.89416+03	1.709	1.473
5.000+02	3.11461-03	9.44088+03	6.87222+12	2.32519+12	3.40168+02	5.30547+03	1.853	1.441
5.000+02	3.11461-03	9.44088+03	6.87222+12	2.32519+12	2.78307+02	2.83877+03	1.853	1.441
2.500+03	5.93811-04	1.85725+03	7.34735+12	2.65554+12	8.79269+01	1.91294+03	1.944	1.426
2.500+03	5.93811-04	1.85725+03	7.34735+12	2.65554+12	7.22380+01	7.15306+02	1.944	1.426
1.250+04	1.15849-04	3.68355+02	7.65571+12	2.88601+12	2.19000+01	1.03806+03	1.993	1.415
1.250+04	1.15849-04	3.68355+02	7.65571+12	2.88601+12	1.81657+01	1.72006+02	1.993	1.415
6.250+04	2.28124-05	7.32912+01	8.12103+12	3.30156+12	6.57638+00	8.20639+02	2.024	1.396
6.250+04	2.28124-05	7.32912+01	8.12103+12	3.30156+12	5.57838+00	4.65246+01	2.024	1.396
3.400+05	3.99187-06	1.32585+01	9.95090+12	4.96854+12	2.91108+00	7.00671+02	2.126	1.334
3.400+05	3.99187-06	1.32585+01	9.95090+12	4.96854+12	2.56078+00	1.80856+01	2.126	1.334
2.000+06	5.87209-07	2.15683+00	1.58953+13	1.03855+13	1.40859+00	4.39933+02	2.457	1.231
2.000+06	5.87209-07	2.15683+00	1.58953+13	1.03855+13	1.28912+00	8.42694+00	2.457	1.231
1.300+07	7.79751-08	3.18683-01	2.29036+13	1.67728+13	5.22311-01	1.42225+02	2.847	1.178
1.300+07	7.79751-08	3.18683-01	2.29036+13	1.67728+13	5.02265-01	2.28228+00	2.847	1.178
1.000+08	9.63879-09	4.08997-02	2.56489+13	1.92837+13	2.44150-01	4.07754+01	2.994	1.165
1.000+08	9.63879-09	4.08997-02	2.56489+13	1.92837+13	2.41104-01	3.54320-01	2.994	1.165
8.500+08	1.08551-09	4.76024-03	2.88161+13	2.22378+13	1.88708-01	2.23648+01	3.128	1.152
8.500+08	1.08551-09	4.76024-03	2.88161+13	2.22378+13	1.88230-01	5.48731-02	3.128	1.152
8.000+09	1.00622-10	4.90144-04	4.01058+13	3.27987+13	1.79444-01	9.86856+00	3.585	1.121
8.000+09	1.00622-10	4.90144-04	4.01058+13	3.27987+13	1.79390-01	1.11262-02	3.585	1.121
8.500+10	8.62249-12	4.52304-05	4.88192+13	4.09503+13	1.77349-01	1.47509+00	3.937	1.107
8.500+10	8.62249-12	4.52304-05	4.88192+13	4.09503+13	1.77349-01	1.43265-03	3.937	1.107

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 15.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.57082-01	6.72766+05	7.14119+12	7.16459+11	2.09823+03	2.64811+04	1.687	1.600
2.000+01	1.57082-01	6.72766+05	7.14119+12	7.16459+11	1.09662+03	1.53407+04	1.687	1.600
1.000+02	2.83546-02	1.29674+05	8.75281+12	1.89245+12	7.16824+02	1.50162+04	1.870	1.522
1.000+02	2.83546-02	1.29674+05	8.75281+12	1.89245+12	3.76547+02	4.82811+03	1.870	1.522
5.000+02	5.36862-03	2.54530+04	1.02103+13	3.09822+12	2.46287+02	1.11475+04	1.975	1.464
5.000+02	5.36862-03	2.54530+04	1.02103+13	3.09822+12	1.30732+02	1.72249+03	1.975	1.464
2.500+03	9.98655-04	4.97097+03	1.29715+13	5.50456+12	1.02828+02	8.98291+03	2.123	1.384
2.500+03	9.98655-04	4.97097+03	1.29715+13	5.50456+12	5.64112+01	8.09212+02	2.123	1.384
1.250+04	1.71191-04	9.48711+02	1.91570+13	1.08438+13	4.57430+01	5.97045+03	2.477	1.289
1.250+04	1.71191-04	9.48711+02	1.91570+13	1.08438+13	2.76278+01	4.02301+02	2.477	1.289
6.250+04	2.99538-05	1.82914+02	2.57331+13	1.65727+13	1.44304+01	2.80422+03	2.832	1.237
6.250+04	2.99538-05	1.82914+02	2.57331+13	1.65727+13	1.00936+01	1.38881+02	2.832	1.237
3.400+05	5.12966-06	3.30239+01	3.00561+13	2.03988+13	4.07660+00	1.58934+03	3.040	1.214
3.400+05	5.12966-06	3.30239+01	3.00561+13	2.03988+13	3.24701+00	3.52171+01	3.040	1.214
2.000+06	7.96245-07	5.49327+00	3.72350+13	2.68859+13	1.47494+00	7.95096+02	3.329	1.185
2.000+06	7.96245-07	5.49327+00	3.72350+13	2.68859+13	1.39232+00	9.72633+00	3.329	1.165
1.300+07	1.08324-07	8.22528-01	4.83324+13	3.69419+13	5.12099-01	2.67126+02	3.765	1.157
1.300+07	1.08324-07	8.22528-01	4.83324+13	3.69419+13	4.60849-01	2.42240+00	3.765	1.157
1.000+08	1.33826-08	1.05814-01	5.33614+13	4.15004+13	2.37399-01	4.33924+01	3.962	1.148
1.000+08	1.33826-08	1.05814-01	5.33614+13	4.15004+13	2.33699-01	3.70224-01	3.962	1.148
8.500+08	1.56110-09	1.24275-02	5.42283+13	4.22865+13	1.84647-01	5.28449+00	3.995	1.147
8.500+08	1.56110-09	1.24275-02	5.42283+13	4.22865+13	1.84341-01	4.47087-02	3.995	1.147
8.000+09	1.65694-10	1.32014-03	5.43369+13	4.23851+13	1.77900-01	5.64004-01	3.999	1.147
8.000+09	1.65694-10	1.32014-03	5.43369+13	4.23851+13	1.77884-01	4.76685-03	3.999	1.147
8.500+10	1.55929-11	1.24246-04	5.43491+13	4.23962+13	1.77177-01	5.31137-02	4.000	1.147
8.500+10	1.55929-11	1.24246-04	5.43491+13	4.23962+13	1.77175-01	4.48858-04	4.000	1.147

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.43819-01	1.74693+06	1.29218+13	2.17382+12	3.81966+03	4.00621+04	1.997	1.554
2.000+01	2.43819-01	1.74693+06	1.29218+13	2.17382+12	1.26440+03	1.20149+04	1.997	1.554
1.000+02	4.51586-02	3.40768+05	1.74579+13	6.13816+12	1.74603+03	3.02103+04	2.157	1.432
1.000+02	4.51586-02	3.40768+05	1.74579+13	6.13816+12	5.98252+02	6.23062+03	2.157	1.432
5.000+02	7.73790-03	6.50608+04	2.46738+13	1.20609+13	7.31080+02	2.01971+04	2.517	1.341
5.000+02	7.73790-03	6.50608+04	2.46738+13	1.20609+13	2.78625+02	3.04348+03	2.517	1.341
2.500+03	1.35272-03	1.25464+04	3.22819+13	1.83686+13	2.28066+02	1.17700+04	2.880	1.287
2.500+03	1.35272-03	1.25464+04	3.22819+13	1.83686+13	1.07863+02	1.13305+03	2.880	1.287
1.250+04	2.40204-04	2.43675+03	4.06288+13	2.54111+13	6.81381+01	7.04080+03	3.244	1.250
1.250+04	2.40204-04	2.43675+03	4.06288+13	2.54111+13	3.95587+01	4.01258+02	3.244	1.250
6.250+04	4.25815-05	4.74299+02	5.12656+13	3.45567+13	1.81967+01	3.06867+03	3.660	1.217
6.250+04	4.25815-05	4.74299+02	5.12656+13	3.45567+13	1.34402+01	1.32474+02	3.660	1.217
3.400+05	7.32001-06	8.59742+01	5.79444+13	4.03257+13	3.77346+00	7.76339+02	3.913	1.203
3.400+05	7.32001-06	8.59742+01	5.79444+13	4.03257+13	3.26014+00	3.09197+01	3.913	1.203
2.000+06	1.22233-06	1.45629+01	5.98536+13	4.19816+13	7.61329-01	1.43260+02	3.984	1.199
2.000+06	1.22233-06	1.45629+01	5.98536+13	4.19816+13	6.99607-01	5.61140+00	3.984	1.199
1.300+07	1.87416-07	2.23892+00	6.02390+13	4.23185+13	2.85194-01	2.24510+01	3.997	1.198
1.300+07	1.87416-07	2.23892+00	6.02390+13	4.23185+13	2.76403-01	8.76782-01	3.997	1.198
1.000+08	2.43508-08	2.91028-01	6.03103+13	4.23820+13	1.99238-01	2.93168+00	4.000	1.198
1.000+08	2.43508-08	2.91028-01	6.03103+13	4.23820+13	1.97974-01	1.14437-01	4.000	1.198
8.500+08	2.86460-09	3.42381-02	6.03232+13	4.23939+13	1.83913-01	3.45308-01	4.000	1.198
8.500+08	2.86460-09	3.42381-02	6.03232+13	4.23939+13	1.83792-01	1.34782-02	4.000	1.198
8.000+09	3.04361-10	3.63779-03	6.03260+13	4.23965+13	1.79222-01	3.67019-02	4.000	1.198
8.000+09	3.04361-10	3.63779-03	6.03260+13	4.23965+13	1.79220-01	1.43255-03	4.000	1.198
8.500+10	2.86457-11	3.42380-04	6.03268+13	4.23973+13	1.77336-01	3.45468-03	4.000	1.198
8.500+10	2.86457-11	3.42380-04	6.03268+13	4.23973+13	1.77336-01	1.34843-04	4.000	1.198

BERYLLIUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.72805-01	4.61426+06	2.67039+13	8.13699+12	1.17611+04	4.02763+04	2.426	1.463
2.000+01	3.72805-01	4.61426+06	2.67039+13	8.13699+12	2.30881+03	1.24215+04	2.426	1.463
1.000+02	6.50968-02	8.88665+05	3.58905+13	1.54120+13	5.04904+03	2.79894+04	2.779	1.380
1.000+02	6.50968-02	8.88665+05	3.58905+13	1.54120+13	1.54204+03	6.24170+05	2.779	1.380
5.000+02	1.12434-02	1.71318+05	4.75386+13	2.46814+13	1.52161+03	1.66731+04	3.218	1.321
5.000+02	1.12434-02	1.71318+05	4.75386+13	2.46814+13	5.75302+02	2.59066+05	3.218	1.321
2.500+03	1.99243-03	3.33379+04	5.93869+13	3.42869+13	3.19180+02	6.99291+03	3.632	1.282
2.500+03	1.99243-03	3.33379+04	5.93869+13	3.42869+13	1.60131+02	8.92137+02	3.632	1.282
1.250+04	3.73801-04	6.57841+03	6.62072+13	3.98075+13	5.16959+01	1.93616+03	3.872	1.266
1.250+04	3.73801-04	6.57841+03	6.62072+13	3.98075+13	3.13235+01	2.30547+03	3.872	1.266
6.250+04	7.29488-05	1.30914+03	6.85496+13	4.16289+13	7.76599+00	4.39564+02	3.968	1.262
6.250+04	7.29488-05	1.30914+03	6.85496+13	4.16289+13	4.96375+00	5.11374+01	3.968	1.262
3.400+05	1.33232-05	2.40338+02	6.92235+13	4.21631+13	1.33559+00	8.43965+01	3.994	1.261
3.400+05	1.33232-05	2.40338+02	6.92235+13	4.21631+13	1.02948+00	9.76876+00	3.994	1.261
2.000+06	2.26207-06	4.08471+01	6.94072+13	4.23195+13	4.35783-01	1.45516+01	3.999	1.260
2.000+06	2.26207-06	4.08471+01	6.94072+13	4.23195+13	4.00220-01	1.68268+00	3.999	1.260
1.300+07	3.47934-07	6.28389+00	6.94627+13	4.23701+13	2.64340-01	2.25001+00	4.000	1.260
1.300+07	3.47934-07	6.28389+00	6.94627+13	4.23701+13	2.55002-01	2.60138-01	4.000	1.260
1.000+08	4.52298-08	8.16901-01	6.94815+13	4.23881+13	2.06074-01	2.93060-01	4.000	1.260
1.000+08	4.52298-08	8.16901-01	6.94815+13	4.23881+13	2.04717-01	3.38816-02	4.000	1.260
8.500+08	5.32113-09	9.61059-02	6.94878+13	4.23944+13	1.82688-01	3.45011-02	4.000	1.266
8.500+08	5.32113-09	9.61059-02	6.94878+13	4.23944+13	1.82556-01	3.98877-03	4.000	1.260
8.000+09	5.65370-10	1.02112-02	6.94900+13	4.23965+13	1.77711-01	3.66660-03	4.000	1.260
8.000+09	5.65370-10	1.02112-02	6.94900+13	4.23965+13	1.77697-01	4.23906-04	4.000	1.260
8.500+10	5.32113-11	9.61058-04	6.94907+13	4.23972+13	1.77110-01	3.45119-04	4.000	1.260
8.500+10	5.32113-11	9.61058-04	6.94907+13	4.23972+13	1.77109-01	3.99002-05	4.000	1.260

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.68555-01	3.34805+04	2.89640+11	1.02624+11	6.52473+03	9.71384+04	0.042	1.430
2.000+01	2.68555-01	3.34805+04	2.89640+11	1.02624+11	3.11172+03	3.56347+04	0.042	1.430
1.000+02	2.56244-02	3.33429+03	3.34391+11	1.39196+11	5.55345+03	8.87738+04	0.087	1.389
1.000+02	2.56244-02	3.33429+03	3.34391+11	1.39196+11	2.62231+03	3.01403+04	0.087	1.389
5.000+02	1.95376-03	2.87290+02	4.77697+11	2.57317+11	4.81037+03	7.53427+04	0.228	1.308
5.000+02	1.95376-03	2.87290+02	4.77697+11	2.57317+11	2.31188+03	2.57102+04	0.228	1.308
2.500+03	1.67455-04	3.07304+01	7.80542+11	5.05253+11	2.80328+03	4.60380+04	0.533	1.235
2.500+03	1.67455-04	3.07304+01	7.80542+11	5.05253+11	1.40222+03	1.55615+04	0.533	1.235
1.250+04	2.14433-05	4.70403+00	1.08509+12	7.56012+11	9.77069+02	1.72399+04	0.833	1.202
1.250+04	2.14433-05	4.70403+00	1.08509+12	7.56012+11	5.08242+02	5.58814+03	0.833	1.202
6.250+04	3.72140-06	8.72908-01	1.21932+12	8.67448+11	2.46490+02	5.10802+03	0.960	1.192
6.250+04	3.72140-06	8.72908-01	1.21932+12	8.67448+11	1.31409+02	1.38690+03	0.960	1.192
3.400+05	6.58314-07	1.57377-01	1.26583+12	9.07218+11	5.36413+01	1.90658+03	0.997	1.189
3.400+05	6.58314-07	1.57377-01	1.26583+12	9.07218+11	3.11195+01	2.79810+02	0.997	1.189
2.000+06	1.08503-07	2.63459-02	1.32729+12	9.63050+11	1.29790+01	1.23110+03	1.029	1.183
2.000+06	1.08503-07	2.63459-02	1.32729+12	9.63050+11	8.81775+00	5.52650+01	1.029	1.183
1.300+07	1.47345-08	3.81882-03	1.62027+12	1.23149+12	4.19380+00	9.63239+02	1.165	1.160
1.300+07	1.47345-08	3.81882-03	1.62027+12	1.23149+12	3.17987+00	1.42349+01	1.165	1.160
1.000+08	1.39277-09	4.33879-04	2.55973+12	2.09242+12	1.37426+00	4.52408+02	1.603	1.122
1.000+08	1.39277-09	4.33879-04	2.55973+12	2.09242+12	1.14780+00	4.24433+00	1.603	1.122
8.500+08	1.36212-10	4.77359-05	3.25864+12	2.73293+12	4.01648-01	8.36451+01	1.928	1.108
8.500+08	1.36212-10	4.77359-05	3.25864+12	2.73293+12	3.78678-01	7.09947-01	1.928	1.108
8.000+09	1.40065-11	5.01615-06	3.39693+12	2.85970+12	2.24094-01	1.13154+01	1.992	1.105
8.000+09	1.40065-11	5.01615-06	3.39693+12	2.85970+12	2.23079-01	7.99181-02	1.992	1.105
8.500+10	1.31201-12	4.71361-07	3.42114+12	2.88221+12	2.01886-01	2.91667+00	2.002	1.105
8.500+10	1.31201-12	4.71361-07	3.42114+12	2.88221+12	2.01823-01	7.60956-03	2.002	1.105
1.000+11	1.11492-12	4.00622-07	3.42299+12	2.88396+12	2.01526-01	2.78401+00	2.002	1.105
1.000+11	1.11492-12	4.00622-07	3.42299+12	2.88396+12	2.01474-01	6.47505-03	2.002	1.105

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	8.51344-02	1.89665+04	5.89317+11	2.55122+11	3.71114+04	1.71038+05	0.241	1.378
2.000+01	8.51344-02	1.89665+04	5.89317+11	2.55122+11	1.39261+04	8.78131+04	0.241	1.378
1.000+02	9.49820-03	2.44157+03	9.30118+11	4.44510+11	2.64393+04	1.19248+05	0.432	1.310
1.000+02	9.49820-03	2.44157+03	9.30118+11	4.44510+11	9.73413+03	5.56200+04	0.432	1.310
5.000+02	1.15049-03	3.53810+02	1.15532+12	6.93999+11	1.46507+04	6.68264+04	0.713	1.266
5.000+02	1.15049-03	3.53810+02	1.15532+12	6.93999+11	5.21314+03	2.75352+04	0.713	1.266
2.500+03	1.77786-04	6.13697+01	1.40249+12	8.84679+11	6.80778+03	3.29085+04	0.923	1.246
2.500+03	1.77786-04	6.13697+01	1.40249+12	8.84679+11	1.95132+03	9.09515+03	0.923	1.246
1.250+04	3.17076-05	1.15828+01	1.58731+12	1.03932+12	2.23339+03	2.04113+04	1.035	1.230
1.250+04	3.17076-05	1.15828+01	1.58731+12	1.03932+12	7.30749+02	2.63165+03	1.035	1.230
6.250+04	5.42487-06	2.15197+00	1.97677+12	1.38171+12	7.42389+02	1.48292+04	1.209	1.201
6.250+04	5.42487-06	2.15197+01	1.97677+12	1.38171+12	3.08389+02	9.38331+02	1.209	1.201
3.400+05	7.61226-07	3.53213-01	2.84282+12	2.14676+12	1.72574+02	7.90124+03	1.584	1.163
3.400+05	7.61226-07	3.53213-01	2.84282+12	2.14676+12	9.74845+01	3.47768+02	1.584	1.163
2.000+06	1.08389-07	5.62723-02	3.55899+12	2.78018+12	2.74135+01	2.61048+03	1.892	1.146
2.000+06	1.08389-07	5.62723-02	3.55899+12	2.78018+12	1.91742+01	8.51602+01	1.892	1.146
1.300+07	1.58233-08	8.50432-03	3.81462+12	3.00839+12	4.40406+00	1.03528+03	1.993	1.141
1.300+07	1.58233-08	8.50432-03	3.81462+12	3.00839+12	3.57668+00	1.47523+01	1.993	1.141
1.000+08	1.96671-09	1.08934-03	4.15285+12	3.32196+12	9.10954-01	7.03926+02	2.085	1.133
1.000+08	1.96671-09	1.08934-03	4.15285+12	3.32196+12	8.06226-01	2.29581+00	2.085	1.133
8.500+08	1.97049-10	1.21995-04	5.59500+12	4.66628+12	3.44162-01	4.26307+02	2.448	1.111
8.500+08	1.97049-10	1.21995-04	5.59500+12	4.66628+12	3.30028-01	4.64694-01	2.448	1.111
8.000+09	1.77634-11	1.23923-05	7.33653+12	6.29002+12	2.29445-01	1.32308+02	2.886	1.095
8.000+09	1.77634-11	1.23923-05	7.33653+12	6.29002+12	2.28121-01	7.44282-02	2.886	1.095
8.500+10	1.60718-12	1.15472-06	7.81595+12	6.73817+12	2.02953-01	6.23914+01	3.002	1.092
8.500+10	1.60718-12	1.15472-06	7.81595+12	6.73817+12	2.02879-01	7.70335-03	3.002	1.092
1.000+11	1.36419-12	9.81168-07	7.83605+12	6.75714+12	2.02456-01	6.10521+01	3.006	1.092
1.000+11	1.36419-12	9.81168-07	7.83605+12	6.75714+12	2.02395-01	6.57895-03	3.006	1.092

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 3.400

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	6.75986-02	2.86732+04	1.21293+12	5.76635+11	1.22105+05	1.72877+05	0.563	1.350
2.000+01	6.75986-02	2.86732+04	1.21293+12	5.76635+11	4.62547+04	9.06589+04	0.563	1.350
1.000+02	9.62292-03	4.67739+03	1.64727+12	9.18126+11	7.20426+04	1.16326+05	0.792	1.295
1.000+02	9.62292-03	4.67739+03	1.64727+12	9.18126+11	2.41223+04	4.27556+04	0.792	1.295
5.000+02	1.45919-03	8.09213+02	2.14247+12	1.31058+12	3.28407+04	8.48833+04	1.044	1.259
5.000+02	1.45919-03	8.09213+02	2.14247+12	1.31058+12	1.06357+04	1.91234+04	1.044	1.259
2.500+03	2.21955-04	1.42883+02	2.87170+12	1.90602+12	9.68450+03	6.04893+04	1.373	1.224
2.500+03	2.21955-04	1.42883+02	2.87170+12	1.90602+12	3.36385+03	8.30206+03	1.373	1.224
1.250+04	3.48935-05	2.59998+01	3.79537+12	2.67762+12	2.29088+03	3.60511+04	1.746	1.196
1.250+04	3.48935-05	2.59998+01	3.79537+12	2.67762+12	8.16839+02	3.10604+03	1.746	1.196
6.250+04	6.12974-06	4.96963+00	4.47474+12	3.25856+12	5.60148+02	2.25144+04	1.988	1.181
6.250+04	6.12974-06	4.96963+00	4.47474+12	3.25856+12	2.29448+02	8.94636+02	1.988	1.181
3.400+05	1.00228-06	8.79753-01	5.38412+12	4.06741+12	1.44981+02	1.59288+04	2.235	1.163
3.400+05	1.00228-06	8.79753-01	5.38412+12	4.06741+12	7.65177+01	2.49280+02	2.235	1.163
2.000+06	1.43362-07	1.42226-01	7.05871+12	5.57050+12	3.19614+01	9.13393+03	2.657	1.141
2.000+06	1.43362-07	1.42226-01	7.05871+12	5.57050+12	2.08873+01	7.02982+01	2.657	1.141
1.300+07	1.98451-08	2.12812-02	8.27620+12	6.66756+12	5.39750+00	4.92129+03	2.953	1.130
1.300+07	1.98451-08	2.12812-02	8.27620+12	6.66756+12	4.06562+00	1.41980+01	2.953	1.130
1.000+08	2.39896-09	2.71747-03	9.39068+12	7.69142+12	1.00473+00	3.32305+03	3.175	1.121
1.000+08	2.39896-09	2.71747-03	9.39068+12	7.69142+12	8.65693-01	2.37504+00	3.175	1.121
8.500+08	2.44981-10	3.09596-04	1.19928+13	1.00970+13	3.39317-01	1.34265+03	3.658	1.105
8.500+08	2.44981-10	3.09596-04	1.19928+13	1.00970+13	3.25223-01	4.35124-01	3.658	1.105
8.000+09	2.41188-11	3.23763-05	1.35608+13	1.15472+13	2.24377-01	2.04475+02	3.948	1.099
8.000+09	2.41188-11	3.23763-05	1.35608+13	1.15472+13	2.23002-01	5.62640-02	3.948	1.099
8.500+10	2.24324-12	3.03992-06	1.38159+13	1.17831+13	2.02296-01	2.01976+01	3.995	1.098
8.500+10	2.24324-12	3.03992-06	1.38159+13	1.17831+13	2.02221-01	5.45052-03	3.995	1.098
1.000+11	1.90639-12	2.58383-06	1.38201+13	1.17870+13	2.01875-01	1.71814+01	3.996	1.098
1.000+11	1.90639-12	2.58383-06	1.38201+13	1.17870+13	2.01817-01	4.63515-03	3.996	1.098

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	6.98781-02	5.49794+04	2.30190+12	1.12164+12	1.37937+05	1.80907+05	0.972	1.342
2.000+01	6.98781-02	5.49794+04	2.30190+12	1.12164+12	5.22511+04	7.68330+04	0.972	1.342
1.000+02	1.10274-02	9.81959+03	3.11710+12	1.78131+12	8.66545+04	1.36096+05	1.232	1.286
1.000+02	1.10274-02	9.81959+03	3.11710+12	1.78131+12	2.60959+04	3.82953+04	1.232	1.286
5.000+02	1.67198-03	1.75106+03	4.25956+12	2.68852+12	3.74477+04	1.02614+05	1.625	1.246
5.000+02	1.67198-03	1.75106+03	4.25956+12	2.68852+12	8.85666+03	1.72721+04	1.625	1.246
2.500+03	2.69822-04	3.24448+02	5.47643+12	3.67264+12	1.46374+04	7.90501+04	2.014	1.220
2.500+03	2.69822-04	3.24448+02	5.47643+12	3.67264+12	3.11881+03	6.82728+03	2.014	1.220
1.250+04	4.45491-05	6.11331+01	7.02541+12	4.96689+12	3.86034+03	5.88261+04	2.439	1.195
1.250+04	4.45491-05	6.11331+01	7.02541+12	4.96689+12	1.14976+03	2.53219+03	2.439	1.195
6.250+04	7.64103-06	1.17204+01	8.69012+12	6.38916+12	7.71273+02	3.97746+04	2.844	1.177
6.250+04	7.64103-06	1.17204+01	8.69012+12	6.38916+12	2.97180+02	8.10017+02	2.844	1.177
3.400+05	1.25844-06	2.09617+00	1.02864+13	7.78774+12	1.48204+02	2.66005+04	3.175	1.162
3.400+05	1.25844-06	2.09617+00	1.02864+13	7.78774+12	7.33171+01	2.16243+02	3.175	1.162
2.000+06	1.88089-07	3.46036-01	1.26479+13	9.88808+12	2.74311+01	1.22900+04	3.611	1.145
2.000+06	1.88089-07	3.46036-01	1.26479+13	9.88808+12	1.70408+01	5.55742+01	3.611	1.145
1.300+07	2.67170-08	5.23507-02	1.43027+13	1.13633+13	4.08043+00	2.79814+03	3.911	1.137
1.300+07	2.67170-08	5.23507-02	1.43027+13	1.13633+13	3.10512+00	1.06690+01	3.911	1.137
1.000+08	3.40674-09	6.77908-03	1.47283+13	1.17433+13	6.86636-01	3.95860+02	3.987	1.135
1.000+08	3.40674-09	6.77908-03	1.47283+13	1.17433+13	6.19392-01	1.46350+00	3.987	1.135
8.500+08	3.99683-10	7.97095-04	1.47919+13	1.18003+13	2.68810-01	4.72061+01	3.998	1.135
8.500+08	3.99683-10	7.97095-04	1.47919+13	1.18003+13	2.62220-01	1.73794-01	3.998	1.135
8.000+09	4.24520-11	8.46857-05	1.48003+13	1.18078+13	2.10213-01	5.02707+00	4.000	1.135
8.000+09	4.24520-11	8.46857-05	1.48003+13	1.18078+13	2.08646-01	1.84984-02	4.000	1.135
8.500+10	3.99534-12	7.97036-06	1.48014+13	1.18088+13	2.01651-01	4.73359-01	4.000	1.135
8.500+10	3.99534-12	7.97036-06	1.48014+13	1.18088+13	2.01397-01	1.74175-03	4.000	1.135
1.000+11	3.39604-12	6.77480-06	1.48014+13	1.18089+13	2.01407-01	4.02361-01	4.000	1.135
1.000+11	3.39604-12	6.77480-06	1.48014+13	1.18089+13	2.01209-01	1.48051-03	4.000	1.135

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 7.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KRGS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EG-M
2.000+01	7.94535-02	1.07227+05	5.81238+12	1.78792+12	9.32758+04	1.74196+05	1.416	1.354
2.000+01	7.94535-02	1.07227+05	5.81238+12	1.78792+12	4.23382+04	6.65106+04	1.416	1.354
1.000+02	1.28134-02	1.97265+04	5.31301+12	3.00360+12	7.97051+04	1.32897+05	1.756	1.290
1.000+02	1.28134-02	1.97265+04	5.31301+12	3.00360+12	2.24346+04	3.11513+04	1.756	1.290
5.000+02	2.09539-03	3.66193+03	7.09893+12	4.38633+12	4.61947+04	1.06137+05	2.190	1.252
5.000+02	2.09539-03	3.66193+03	7.09893+12	4.38633+12	9.52778+03	1.40856+04	2.190	1.252
2.500+03	3.36093-04	6.90501+02	9.16377+12	6.08184+12	1.42758+04	8.00365+04	2.678	1.224
2.500+03	3.36093-04	6.90501+02	9.16377+12	6.08184+12	2.87492+03	5.51426+03	2.678	1.224
1.250+04	5.69807-05	1.32381+02	1.13990+13	7.87384+12	3.29464+03	5.63447+04	3.199	1.205
1.250+04	5.69807-05	1.32381+02	1.13990+13	7.87384+12	8.81445+02	1.94874+03	3.199	1.205
6.250+04	9.98931-06	2.56793+01	1.37612+13	9.89717+12	6.99674+02	2.71133+04	3.611	1.187
6.250+04	9.98931-06	2.56793+01	1.37612+13	9.89717+12	2.99745+02	6.13492+02	3.611	1.187
3.400+05	1.69680-06	4.64572+00	1.53603+13	1.12580+13	9.02726+01	7.34416+03	3.896	1.178
3.400+05	1.69680-06	4.64572+00	1.53603+13	1.12580+13	4.98480+01	1.44185+02	3.896	1.175
2.000+06	2.82672-07	7.86352-01	1.58594+13	1.16864+13	1.12388+01	1.39542+03	3.980	1.175
2.000+06	2.82672-07	7.86352-01	1.58594+13	1.16864+13	7.79353+00	2.65487+01	3.980	1.175
1.300+07	4.33071-08	1.20876-01	1.59089+13	1.17820+13	1.65362+00	2.20970+02	3.997	1.175
1.300+07	4.33071-08	1.20876-01	1.59089+13	1.17820+13	1.36017+00	4.18008+00	3.997	1.175
1.000+08	5.62610-09	1.57118-02	1.59918+13	1.18026+13	4.13360-01	2.89638+01	4.000	1.175
1.000+08	5.62610-09	1.57118-02	1.59918+13	1.18026+13	3.90656-01	5.47404-01	4.000	1.175
8.500+08	6.61635-10	1.84841-03	1.59988+13	1.18073+13	2.39244-01	3.41801+00	4.000	1.175
8.500+08	6.61635-10	1.84841-03	1.59988+13	1.18073+13	2.37406-01	6.45533-02	4.000	1.175
8.000+09	7.03192-11	1.96383-04	1.59981+13	1.18089+13	2.08279-01	3.63243-01	4.000	1.175
8.000+09	7.03192-11	1.96383-04	1.59981+13	1.18089+13	2.07994-01	6.86420-03	4.000	1.175

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 10.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.79765-02	2.31478+05	6.17233+12	2.62823+12	4.25846+04	1.42045+05	1.961	1.383
2.000+01	9.79765-02	2.31478+05	6.17233+12	2.62823+12	2.77906+04	5.16742+04	1.961	1.383
1.000+02	1.61819-02	4.35719+04	8.52267+12	4.48347+12	3.92492+04	1.07893+05	2.374	1.316
1.000+02	1.61819-02	4.35719+04	8.52267+12	4.48347+12	1.70400+04	2.35930+04	2.374	1.316
5.000+02	2.71610-03	8.29921+03	1.12438+13	6.66020+12	2.58644+04	7.46338+04	2.829	1.272
5.000+02	2.71610-03	8.29921+03	1.12438+13	6.66020+12	7.17682+03	1.00758+04	2.829	1.272
2.500+03	4.56125-04	1.59034+03	1.41719+13	8.94163+12	9.15190+03	4.28556+04	3.369	1.246
2.500+03	4.56125-04	1.59034+03	1.41719+13	8.94163+12	2.38248+03	3.74245+03	3.369	1.246
1.250+04	8.17481-05	3.10506+02	1.63586+13	1.06607+13	1.70418+03	1.56942+04	3.760	1.231
1.250+04	8.17481-05	3.10506+02	1.63586+13	1.06607+13	5.52896+02	1.12244+03	3.760	1.231
6.250+04	1.56057-05	6.15076+01	1.73386+13	1.14262+13	2.32595+02	4.06317+03	3.939	1.227
6.250+04	1.56057-05	6.15076+01	1.73386+13	1.14262+13	1.03670+02	2.73906+02	3.939	1.227
3.400+05	2.83373-06	1.12787+01	1.76568+13	1.16862+13	3.12514+01	8.16940+02	3.988	1.225
3.400+05	2.83373-06	1.12787+01	1.76568+13	1.16862+13	1.84779+01	5.43149+01	3.988	1.225
2.000+06	4.80527-07	1.91641+00	1.77496+13	1.17670+13	4.67707+00	1.43332+02	3.996	1.225
2.000+06	4.80527-07	1.91641+00	1.77496+13	1.17670+13	3.43901+00	9.50356+00	3.996	1.225
1.300+07	7.38939-08	2.94805-01	1.77788+13	1.17940+13	9.22661-01	2.23156+01	4.000	1.224
1.300+07	7.38939-08	2.94805-01	1.77788+13	1.17940+13	8.07558-01	1.47890+00	4.000	1.224
1.000+08	9.60552-09	3.83241-02	1.77890+13	1.18039+13	3.39007-01	2.91466+00	4.000	1.224
1.000+08	9.60552-09	3.83241-02	1.77890+13	1.18039+13	3.28416-01	1.93140-01	4.000	1.224
8.500+08	1.13005-09	4.50871-03	1.77924+13	1.18073+13	2.24974-01	3.43570-01	4.000	1.224
8.500+08	1.13005-09	4.50871-03	1.77924+13	1.18073+13	2.24037-01	2.27605-02	4.000	1.224
8.000+09	1.20068-10	4.79051-04	1.77936+13	1.18085+13	2.02506-01	3.66161-02	4.000	1.224
8.000+09	1.20068-10	4.79051-04	1.77936+13	1.18085+13	2.02483-01	2.41972-03	4.000	1.224
8.500+10	1.13005-11	4.50871-05	1.77941+13	1.18089+13	1.99749-01	3.53838-03	4.000	1.224
8.500+10	1.13005-11	4.50871-05	1.77941+13	1.18089+13	1.99748-01	2.27786-04	4.000	1.224

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 15.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.36147-01	5.85396-05	9.99563+12	3.54563+12	1.21296+04	8.46160+04	2.592	1.430
2.000+01	1.36147-01	5.85396-05	9.99563+12	3.54563+12	1.08267+04	3.45543+04	2.592	1.430
1.000+02	2.36362-02	1.12778-05	1.34554+13	6.29780+12	8.67150+03	5.09307+04	2.986	1.355
1.000+02	2.36362-02	1.12778-05	1.34554+13	6.29780+12	6.91421+03	1.42657+04	2.986	1.355
5.000+02	4.08738-03	2.17898-04	1.67559+13	8.75893+12	4.51149+03	2.54467+04	3.454	1.318
5.000-02	4.08738-03	2.17898-04	1.67559+13	8.75893+12	3.07647+03	5.41609+03	3.454	1.318
2.500+03	7.50572-04	4.27788+03	1.89969+13	1.04471+13	1.44113+03	8.58108+03	3.762	1.300
2.500+03	7.50572-04	4.27788+03	1.89969+13	1.04471+13	8.84523+02	1.62821+03	3.762	1.300
1.250+04	1.44656-04	8.49042+02	2.00540+13	1.12494+13	3.16344+02	2.17493+03	3.904	1.293
1.250+04	1.44656-04	8.49042+02	2.00540+13	1.12494+13	1.97860+02	3.94301+02	3.904	1.293
6.250+04	2.83900-05	1.69161+02	2.05106+13	1.15724+13	6.21534+01	4.96338+02	3.973	1.291
6.250+04	2.83900-05	1.69161-02	2.05106+13	1.15724+13	4.31248+01	8.86035+01	3.973	1.291
3.400+05	5.19560-06	3.10680+01	2.06810+13	1.17109+13	1.09256+01	9.64152+01	3.996	1.289
3.400+05	5.19560-06	3.10680+01	2.06810+13	1.17109+13	8.51199+00	1.70753+01	3.996	1.289
2.000+06	8.82472-07	5.28062+00	2.07461+13	1.17697+13	1.97685+00	1.71896+01	3.999	1.288
2.000+06	8.82472-07	5.28062+00	2.07461+13	1.17697+13	1.74336+00	2.96037+00	3.999	1.288
1.300+07	1.35740-07	8.12374-01	2.07748+13	1.17971+13	5.15931-01	3.14196+00	4.000	1.288
1.300+07	1.35740-07	8.12374-01	2.07748+13	1.17971+13	4.95191-01	4.59503-01	4.000	1.288
1.000+08	1.76424-08	1.05604-01	2.08108+13	1.18315+13	2.51949-01	8.98799-01	4.001	1.288
1.000+08	1.76424-08	1.05604-01	2.08108+13	1.18315+13	2.49208-01	6.02841-02	4.001	1.288
8.500+08	2.07212-09	1.24199-02	2.10347+13	1.20435+13	2.06325-01	5.98339-01	4.008	1.285
8.500+08	2.07212-09	1.24199-02	2.10347+13	1.20435+13	2.05969-01	7.45277-03	4.008	1.285
8.000+09	2.16954-10	1.31577-03	2.29965+13	1.38988+13	2.00252-01	5.30220-01	4.067	1.264
8.000+09	2.16954-10	1.31577-03	2.29965+13	1.38988+13	2.00244-01	1.12508-03	4.067	1.264
8.500+10	1.87358-11	1.21822-04	3.50844+13	2.53306+13	1.99581-01	3.24841-01	4.432	1.185
8.500+10	1.87358-11	1.21822-04	3.50844+13	2.53306+13	1.99581-01	2.99145-04	4.432	1.185

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.13393-01	1.54723+06	1.44797+13	3.60319+12	3.66624+03	3.91150+04	3.038	1.501
2.000+01	2.13393-01	1.54723+06	1.44797+13	3.60319+12	3.24432+03	1.97774+04	3.038	1.501
1.000+02	3.80957-02	3.01217+05	1.88389+13	6.97790+12	1.80590+03	1.78636+04	3.404	1.420
1.000+02	3.80957-02	3.01217+05	1.88389+13	6.97790+12	1.60243+03	7.25299+03	3.404	1.420
5.000+02	7.04122-03	5.92057+04	2.20114+13	9.39790+12	6.05607+02	6.00886+03	3.683	1.382
5.000+02	7.04122-03	5.92057+04	2.20114+13	9.39790+12	5.35723+02	2.19627+03	3.683	1.382
2.500+03	1.33565-03	1.17108+04	2.38239+13	1.06712+13	1.68685+02	1.75363+03	3.883	1.368
2.500+03	1.33565-03	1.17108+04	2.38239+13	1.06712+13	1.48963+02	5.79466+02	3.883	1.368
1.250+04	2.63088-04	2.33491+03	2.46207+13	1.13074+13	3.88156+01	4.83735+02	3.943	1.360
1.250+04	2.63088-04	2.33491+03	2.46207+13	1.13074+13	3.46614+01	1.32671+02	3.943	1.360
6.250+04	5.20295-05	4.65925+02	2.51152+13	1.16818+13	8.82197+00	1.88082+02	3.988	1.357
6.250+04	5.20295-05	4.65925+02	2.51152+13	1.16818+13	8.03888+00	2.92619+01	3.988	1.357
3.400+05	9.49777-06	8.55286+01	2.57966+13	1.22881+13	2.14769+00	1.20463+02	4.016	1.349
3.400+05	9.49777-06	8.55286+01	2.57966+13	1.22881+13	2.01985+00	6.15112+00	4.016	1.349
2.000+06	1.58193-06	1.44812+01	2.85971+13	1.48651+13	7.51061-01	9.96027+01	4.099	1.320
2.000+06	1.58193-06	1.44812+01	2.85971+13	1.48651+13	7.18476-01	1.59334+00	4.099	1.320
1.300+07	2.25858-07	2.19642+00	3.94135+13	2.48254+13	3.68804-01	6.60255+01	4.416	1.247
1.300+07	2.25858-07	2.19642+00	3.94135+13	2.48254+13	3.55817-01	5.72790-01	4.416	1.247
1.000+08	2.66728-08	2.80708-01	5.46545+13	3.88673+13	2.35114-01	2.28963+01	4.862	1.193
1.000+08	2.66728-08	2.80708-01	5.46545+13	3.88673+13	2.32236-01	1.36037-01	4.862	1.193
8.500+08	2.98606-09	3.27517-02	6.39438+13	4.74905+13	2.05556-01	8.66528+00	5.109	1.172
8.500+08	2.98606-09	3.27517-02	6.39438+13	4.74905+13	2.04652-01	2.17639-02	5.109	1.172
8.000+09	2.90358-10	3.43155-03	8.35940+13	6.58654+13	2.00374-01	3.35626+00	5.582	1.141
8.000+09	2.90358-10	3.43155-03	8.35940+13	6.58654+13	2.00328-01	3.89997-03	5.582	1.141
8.500+10	2.56953-11	3.20038-04	9.84064+13	7.97226+13	1.99563-01	4.93468-01	5.937	1.127
8.500+10	2.56953-11	3.20038-04	9.84064+13	7.97226+13	1.99563-01	4.80981-04	5.937	1.127

CARBON 9/1/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.59744-01	4.24362+[illegible]	2.10010+13	3.30555+12	1.73472+03	1.64149+04	3.348	1.562
2.000+01	3.59744-01	4.24362+[illegible]	2.10010+13	3.30555+12	9.71834+02	9.62243+03	3.348	1.562
1.000+02	6.62694-02	8.33315+[illegible]	2.60282+13	7.16502+12	6.26335+02	7.01439+03	3.635	1.483
1.000+02	6.62694-02	8.33315+[illegible]	2.60282+13	7.16502+12	3.61382+02	3.03059+03	3.635	1.483
5.000+02	1.25490-02	1.64751+[illegible]	2.95180+13	9.82395+12	1.94065+02	3.56971+03	3.839	1.445
5.000+02	1.25490-02	1.64751+[illegible]	2.95180+13	9.82395+12	1.15030+02	9.07411+02	3.839	1.445
2.500+03	2.42873-03	3.27301+[illegible]	3.26421+13	1.24264+13	5.21759+01	2.40966+03	3.967	1.413
2.500+03	2.42873-03	3.27301+[illegible]	3.26421+13	1.24264+13	3.19401+01	2.68536+02	3.967	1.413
1.250+04	4.62808-04	6.48380+[illegible]	3.90199+13	1.80040+13	1.64392+01	1.88159+03	4.164	1.359
1.250+04	4.62808-04	6.48380+[illegible]	3.90199+13	1.80040+13	1.08541+01	1.03577+02	4.164	1.359
6.250+04	8.45326-05	1.27498+[illegible]	5.23689+13	2.97435+13	5.92500+00	1.19805+03	4.559	1.288
6.250+04	8.45326-05	1.27498+[illegible]	5.23689+13	2.97435+13	4.42554+00	4.37816+01	4.559	1.288
3.400+05	1.42974-05	2.31002+[illegible]	6.65217+13	4.22849+13	1.90261+00	5.85606+02	4.955	1.243
3.400+05	1.42974-05	2.31002+[illegible]	6.65217+13	4.22849+13	1.62785+00	1.33794+01	4.955	1.243
2.000+06	2.25693-06	3.87993+[illegible]	8.21052+13	5.63169+13	7.24656-01	2.85373+02	5.336	1.209
2.000+06	2.25693-06	3.87993+[illegible]	8.21052+13	5.63169+13	6.69856-01	3.58772+00	5.336	1.209
1.300+07	3.20481-07	5.89657+[illegible]	1.01216+14	7.36153+13	3.25268-01	8.74410+01	5.782	1.182
1.300+07	3.20481-07	5.89657+[illegible]	1.01216+14	7.36153+13	3.16638-01	8.21584-01	5.782	1.182
1.000+08	4.03808-08	7.63077-[illegible]	1.09149+14	8.08017+13	2.20647-01	1.37928+01	5.965	1.173
1.000+08	4.03808-08	7.63077-[illegible]	1.09149+14	8.08017+13	2.19698-01	1.21661-01	5.965	1.173
8.500+08	4.72641-09	8.97078-[illegible]	1.10481+14	8.20094+13	2.02033-01	1.67178+00	5.996	1.172
8.500+08	4.72641-09	8.97078-[illegible]	1.10481+14	8.20094+13	2.01959-01	1.46163-02	5.996	1.172
8.000+09	5.01864-10	9.53060-[illegible]	1.10648+14	8.21611+13	1.99809-01	1.78320-01	6.000	1.172
8.000+09	5.01864-10	9.53060-[illegible]	1.10648+14	8.21611+13	1.99803-01	1.55738-03	6.000	1.172
8.500+10	4.72310-11	8.96989-[illegible]	1.10667+14	8.21784+13	1.99550-01	1.67917-02	6.000	1.172
8.500+10	4.72310-11	8.96989-[illegible]	1.10667+14	8.21764+13	1.99549-01	1.46636-04	6.000	1.172

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.34381-01	9.71448+14	3.35106+11	1.79146+11	9.18337+02	3.38814+04	0.014	1.310
2.000+01	9.34382-01	9.71448+14	3.35106+11	1.79146+11	6.22886+02	1.19400+04	0.014	1.310
1.000+02	8.63304-02	9.11925+13	3.51633+11	1.93175+11	8.19180+02	3.21966+04	0.030	1.300
1.000+02	8.63304-02	9.11925+13	3.51633+11	1.93175+11	5.50880+02	1.06139+04	0.030	1.300
5.000+02	5.88169-03	6.56526+12	4.13147+11	2.45703+11	7.97106+02	3.04125+04	0.089	1.270
5.000+02	5.88169-03	6.56526+12	4.13147+11	2.45703+11	5.34204+02	1.00775+04	0.089	1.270
2.500+03	3.82262-04	4.98829+11	6.02814+11	4.07061+11	6.22917+02	2.43020+04	0.273	1.216
2.500+03	3.82262-04	4.98829+11	6.02814+11	4.07061+11	4.26765+02	8.04271+03	0.273	1.216
1.250+04	3.36192-05	5.58459+10	9.65167+11	7.15982+11	3.24721+02	1.27696+04	0.620	1.172
1.250+04	3.36192-05	5.58459+10	9.65167+11	7.15982+11	2.23987+02	4.20242+03	0.620	1.172
6.250+04	4.71646-06	9.11087-01	1.24397+12	9.54192+11	1.01674+02	4.01191+03	0.884	1.155
6.250+04	4.71646-06	9.11087-01	1.24397+12	9.54192+11	6.99586+01	1.28611+03	0.884	1.155
3.400+05	7.84938-07	1.59065-01	1.34415+12	1.04016+12	2.28093+01	9.63936+02	0.976	1.151
3.400+05	7.84938-07	1.59065-01	1.34415+12	1.04016+12	1.61671+01	2.71164+02	0.976	1.151
2.000+06	1.30285-07	2.67176-02	1.37419+12	1.06657+12	5.02317+00	2.95362+02	1.000	1.149
2.000+06	1.30285-07	2.67176-02	1.37419+12	1.06657+12	3.92643+00	4.87021+01	1.000	1.149
1.300+07	1.95336-08	4.05809-03	1.42614+12	1.11449+12	1.47472+00	1.71151+02	1.026	1.146
1.300+07	1.95336-08	4.05809-03	1.42614+12	1.11449+12	1.24753+00	8.45855+00	1.026	1.146
1.000+08	2.22015-09	4.94819-04	1.73710+12	1.40276+12	6.33361-01	1.29366+02	1.174	1.128
1.000+08	2.22015-09	4.94819-04	1.73710+12	1.40276+12	5.66407-01	1.86028+00	1.174	1.128
8.500+08	1.86841-10	5.05900-05	2.72265+12	2.31647+12	3.41698-01	5.54704+01	1.641	1.099
8.500+08	1.86841-10	5.05900-05	2.72265+12	2.31647+12	3.28000-01	5.02659-01	1.641	1.099
8.000+09	1.67564-11	5.05780-06	3.36230+12	2.90951+12	2.22112-01	8.86947+00	1.944	1.090
8.000+09	1.67564-11	5.05780-06	3.36230+12	2.90951+12	2.21212-01	7.30212-02	1.944	1.090
8.500+10	1.53679-12	4.71898-07	3.47017+12	3.00954+12	2.01656-01	1.09043+00	1.995	1.088
8.500+10	1.53679-12	4.71898-07	3.47017+12	3.00954+12	2.01549-01	7.18714-03	1.995	1.088

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.56696-01	2.77820+04	5.52391+11	2.86427+11	6.70682+03	1.07573+05	0.153	1.321
2.000+01	1.56696-01	2.77820+04	5.52391+11	2.86427+11	3.53393+03	5.45887+04	0.153	1.321
1.000+02	1.56038-02	3.13620+03	7.43357+11	4.41854+11	5.62765+03	8.24730+04	0.307	1.270
1.000+02	1.56038-02	3.13620+03	7.43357+11	4.41854+11	2.94861+03	3.93745+04	0.307	1.270
5.000+02	1.60813-03	3.94587+02	1.06784+12	6.99766+11	3.48015+03	4.92440+04	0.595	1.230
5.000+02	1.60813-03	3.94587+02	1.06784+12	6.99766+11	1.79895+03	2.26181+04	0.595	1.230
2.500+03	2.22463-04	6.36656+01	1.36284+12	9.33539+11	1.47413+03	2.08249+04	0.861	1.210
2.500+03	2.22463-04	6.36656+01	1.36284+12	9.33539+11	7.23255+02	8.12890+03	0.861	1.210
1.250+04	3.89914-05	1.18870+01	1.51932+12	1.06200+12	5.79080+02	9.08679+03	0.982	1.201
1.250+04	3.89914-05	1.18870+01	1.51932+12	1.06200+12	2.64052+02	2.17439+03	0.982	1.201
6.250+04	7.16029-06	2.27927+00	1.68656+12	1.20905+12	2.40848+02	5.72408+03	1.070	1.189
6.250+04	7.16029-06	2.27927+00	1.68656+12	1.20905+12	1.18498+02	6.04362+02	1.070	1.189
3.400+05	1.08162-06	3.82900-01	2.19205+12	1.66100+12	9.55781+01	3.86865+03	1.302	1.161
3.400+05	1.08162-06	3.82900-01	2.19205+12	1.66100+12	5.70434+01	2.12251+02	1.302	1.161
2.000+06	1.39638-07	5.82889-02	3.09862+12	2.47244+12	2.41392+01	1.60532+03	1.714	1.135
2.000+06	1.39638-07	5.82889-02	3.09862+12	2.47244+12	1.74416+01	6.75752+01	1.714	1.135
1.300+07	1.89515-08	8.57822-03	3.60511+12	2.92611+12	3.68092+00	4.03393+02	1.943	1.126
1.300+07	1.89515-08	8.57822-03	3.60511+12	2.92611+12	3.06506+00	1.32147+01	1.943	1.126
1.000+08	2.38798-09	1.10352-03	3.75613+12	3.06292+12	6.81112-01	1.36182+02	2.005	1.123
1.000+08	2.38798-09	1.10352-03	3.75613+12	3.06292+12	6.28170-01	1.85224+00	2.005	1.123
8.500+08	2.68575-10	1.27925-04	4.07272+12	3.35821+12	2.79279-01	9.07312+01	2.097	1.117
8.500+08	2.68575-10	1.27925-04	4.07272+12	3.35821+12	2.73313-01	2.63884-01	2.097	1.117
8.000+09	2.38901-11	1.28774-05	5.51081+12	4.70222+12	2.19017-01	4.79015+01	2.505	1.098
8.000+09	2.38901-11	1.28774-05	5.51081+12	4.70222+12	2.18069-01	5.05744-02	2.505	1.098
8.500+10	1.93153-12	1.16324-06	6.96146+12	6.05804+12	2.02944-01	8.73079+00	2.916	1.087
8.500+10	1.93153-12	1.16324-06	6.96146+12	6.05804+12	2.02561-01	6.90179-03	2.916	1.087

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 3.400

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.08176-02	3.14407+04	1.07853+12	5.59209+11	4.02388+04	1.27115+05	0.490	1.321
2.000+01	9.08176-02	3.14407+04	1.07853+12	5.59209+11	1.81091+04	7.35165+04	0.490	1.321
1.000+02	1.23733-02	4.94239+03	1.45133+12	8.52131+11	2.40681+04	7.78991+04	0.719	1.275
1.000+02	1.23733-02	4.94239+03	1.45133+12	8.52131+11	1.01685+04	3.54442+04	0.719	1.275
5.000+02	1.86324-03	8.46373+02	1.83201+12	1.15060+12	1.34504+04	4.94683+04	0.954	1.248
5.000+02	1.86324-03	8.46373+02	1.83201+12	1.15060+12	5.36863+03	1.46898+04	0.954	1.248
2.500+03	2.93989-04	1.50993+02	2.33055+12	1.56010+12	5.73828+03	3.39471+04	1.210	1.220
2.500+03	2.93989-04	1.50993+02	2.33055+12	1.56010+12	2.41967+03	5.99632+03	1.210	1.220
1.250+04	4.51955-05	2.70371+01	3.15633+12	2.26093+12	1.36356+03	1.94891+04	1.574	1.189
1.250+04	4.51955-05	2.70371+01	3.15633+12	2.26093+12	6.82853+02	2.39833+03	1.574	1.189
6.250+04	7.58488-06	5.06944+00	3.87944+12	2.87684+12	2.58398+02	8.89378+03	1.876	1.172
6.250+04	7.58488-06	5.06944+00	3.87944+12	2.87684+12	1.38765+02	7.27677+02	1.876	1.172
3.400+05	1.28369-06	9.06178-01	4.34066+12	3.28172+12	6.34209+01	4.82622+03	2.037	1.163
3.400+05	1.28369-06	9.06178-01	4.34066+12	3.28172+12	3.74961+01	1.72399+02	2.037	1.163
2.000+06	1.94497-07	1.48535-01	5.24476+12	4.09916+12	1.84394+01	3.13069+03	2.286	1.146
2.000+06	1.94497-07	1.48535-01	5.24476+12	4.09916+12	1.25873+01	4.45704+01	2.286	1.146
1.300+07	2.50909-08	2.17286-02	6.89721+12	5.59814+12	4.31661+00	1.37400+03	2.726	1.126
1.300+07	2.50909-08	2.17286-02	6.89721+12	5.59814+12	3.32437+00	1.12405+01	2.726	1.126
1.000+08	2.99285-09	2.76220-03	7.84566+12	6.46117+12	8.07760-01	5.03202+02	2.971	1.118
1.000+08	2.99285-09	2.76220-03	7.84566+12	6.46117+12	7.13147-01	1.80744+00	2.971	1.118
8.500+08	3.33986-10	3.20755-04	8.65625+12	7.21558+12	2.92921-01	3.12013+02	3.132	1.111
8.500+08	3.33986-10	3.20755-04	8.65625+12	7.21558+12	2.84387-01	2.58296-01	3.132	1.111
8.000+09	3.08655-11	3.30063-05	1.12124+13	9.60828+12	2.18032-01	1.58160+02	3.601	1.095
8.000+09	3.08655-11	3.30063-05	1.12124+13	9.60828+12	2.17000-01	4.36046-02	3.601	1.095
8.500+10	2.64668-12	3.04644-06	1.31484+13	1.14217+13	2.02147-01	5.68493+01	3.952	1.088
8.500+10	2.64668-12	3.04644-06	1.31484+13	1.14217+13	2.02075-01	5.27384-03	3.952	1.088

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	8.92054-02	5.75888+04	1.96350+12	9.95081+11	9.38771+04	1.29647+05	0.889	1.329
2.000+01	8.92054-02	5.75888+04	1.96350+12	9.95081+11	3.68549+04	6.22678+04	0.889	1.329
1.000+02	1.42395-02	1.02868+04	2.61651+12	1.53282+12	4.70565+04	9.02713+04	1.114	1.276
1.000+02	1.42395-02	1.02868+04	2.61651+12	1.53262+12	1.88782+04	3.03279+04	1.114	1.276
5.000+02	2.15344-03	1.81999+03	3.60632+12	2.33851+12	1.48832+04	5.94482+04	1.473	1.234
5.000+02	2.15344-03	1.81999+03	3.60632+12	2.33851+12	5.57580+03	1.33396+04	1.473	1.234
2.500+03	3.41258-04	3.33432+02	4.57000+12	3.10430+12	4.85245+03	4.03833+04	1.859	1.214
2.500+03	3.41258-04	3.33432+02	4.57000+12	3.10430+12	1.58540+03	5.30117+03	1.859	1.214
1.250+04	5.77092-05	6.30832+01	5.66567+12	4.02589+12	1.67561+03	2.80292+04	2.198	1.193
1.250+04	5.77092-05	6.30832+01	5.66567+12	4.02589+12	6.03747+02	1.84963+03	2.198	1.193
6.250+04	9.72867-06	1.19969+01	7.24193+12	5.39209+12	4.51755+02	1.75774+04	2.608	1.170
6.250+04	9.72867-06	1.19969+01	7.24193+12	5.39209+12	2.21510+02	6.28481+02	2.608	1.170
3.400+05	1.57897-06	2.13375+00	8.69215+12	6.66499+12	9.08902+01	1.03085+04	2.954	1.155
3.400+05	1.57897-06	2.13375+00	8.69215+12	6.66499+12	5.15767+01	1.66725+02	2.954	1.155
2.000+06	2.42371-07	3.53832-01	1.03115+13	8.12153+12	1.88960+01	6.80693+03	3.271	1.142
2.000+06	2.42371-07	3.53832-01	1.03115+13	8.12153+12	1.25675+01	4.05046+01	3.271	1.142
1.300+07	3.26559-08	5.28525-02	1.28670+13	1.04391+13	3.55976+00	3.74520+03	3.735	1.126
1.300+07	3.26559-08	5.28525-02	1.28670+13	1.04391+13	2.77989+00	9.38648+00	3.735	1.126
1.000+08	3.91147-09	6.75674-03	1.47558+13	1.21645+13	7.38722-01	2.12232+03	4.054	1.117
1.000+08	3.91147-09	6.75674-03	1.47558+13	1.21645+13	6.60627-01	1.56189+00	4.054	1.117
8.500+08	4.16004-10	7.79814-04	1.77131+13	1.49011+13	2.95788-01	1.07255+03	4.484	1.106
8.500+08	4.16004-10	7.79814-04	1.77131+13	1.49011+13	2.86078-01	2.58747-01	4.484	1.106
8.000+09	4.04536-11	8.15747-05	2.06192+13	1.75942+13	2.16185-01	2.06300+02	4.900	1.098
8.000+09	4.04536-11	8.15747-05	2.06192+13	1.75942+13	2.15148-01	3.54679-02	4.900	1.098
8.500+10	3.73885-12	7.65419-06	2.12488+13	1.81778+13	2.01265-01	2.13145+01	4.990	1.096
8.500+10	3.73885-12	7.65419-06	2.12488+13	1.81778+13	2.01231-01	3.50185-03	4.990	1.096

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 7.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.96860-02	1.10546+05	3.30585+12	1.64233+12	9.20522+04	1.31453+05	1.318	1.335
2.000+01	9.96860-02	1.10546+05	3.30585+12	1.64233+12	3.26910+04	5.53626+04	1.318	1.335
1.000+02	1.63025-02	2.03700+04	4.54946+12	2.67509+12	5.08758+04	9.34945+04	1.611	1.275
1.000+02	1.63025-02	2.03700+04	4.54946+12	2.67509+12	1.63502+04	2.64258+04	1.611	1.275
5.000+02	2.58058-03	3.74866+03	6.05774+12	3.87864+12	2.36302+04	7.04397+04	2.036	1.240
5.000+02	2.58058-03	3.74866+03	6.05774+12	3.87864+12	5.82335+03	1.15014+04	2.036	1.240
2.500+03	4.18422-04	7.02985+02	7.94738+12	5.42709+12	7.71635+03	5.17002+04	2.511	1.211
2.500+03	4.18422-04	7.02985+02	7.94738+12	5.42709+12	2.05671+03	4.58350+03	2.511	1.211
1.250+04	7.04150-05	1.34247+02	9.94052+12	7.08057+12	1.93463+03	3.82484+04	2.984	1.192
1.250+04	7.04150-05	1.34247+02	9.94052+12	7.08057+12	5.79841+02	1.61789+03	2.984	1.192
6.250+04	1.22243-05	2.59601+01	1.22811+13	9.09539+12	4.75771+02	2.69811+04	3.438	1.173
6.250+04	1.22243-05	2.59601+01	1.22811+13	9.09539+12	1.92310+02	5.28124+02	3.438	1.173
3.400+05	1.98511-06	4.64670+00	1.48897+13	1.13783+13	9.87276+01	1.71193+04	3.892	1.157
3.400+05	1.98511-06	4.64670+00	1.48897+13	1.13783+13	5.20405+01	1.45381+02	3.892	1.157
2.000+06	3.05324-07	7.74558-01	1.75933+13	1.37878+13	1.76533+01	1.00825+04	4.302	1.144
2.000+06	3.05324-07	7.74558-01	1.75933+13	1.37878+13	1.16793+01	3.48588+01	4.302	1.144
1.300+07	4.24366-08	1.16992-01	2.08413+13	1.67057+13	2.85637+00	3.38386+03	4.761	1.132
1.300+07	4.24366-08	1.16992-01	2.08413+13	1.67057+13	2.25967+00	7.36872+00	4.761	1.132
1.000+08	5.29474-09	1.51027-02	2.22687+13	1.79898+13	5.61950-01	5.50729+02	4.961	1.128
1.000+08	5.29474-09	1.51027-02	2.22687+13	1.79898+13	5.15124-01	1.07695+00	4.961	1.128
8.500+08	6.18646-10	1.77475-03	2.25161+13	1.82126+13	2.52529-01	6.71674+01	4.995	1.127
8.500+08	6.18646-10	1.77475-03	2.25161+13	1.82126+13	2.48080-01	1.29340-01	4.995	1.127
8.000+09	6.56753-11	1.88541-04	2.25477+13	1.82413+13	2.06177-01	7.17288+00	4.999	1.127
8.000+09	6.56753-11	1.88541-04	2.25477+13	1.82413+13	2.05842-01	1.37867-02	4.999	1.127
8.500+10	6.18064-12	1.77447-05	2.25515+13	1.82447+13	2.00510-01	6.75627-01	5.000	1.127
8.500+10	6.18064-12	1.77447-05	2.25515+13	1.82447+13	2.00453-01	1.29834-03	5.000	1.127

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 10.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.19297-01	2.34846+05	5.63405+12	2.68100+12	6.76584+04	1.22093+05	1.880	1.349
2.000+01	1.19297-01	2.34846+05	5.63405+12	2.68100+12	2.94000+04	4.55193+04	1.880	1.349
1.000+02	2.01708-02	4.44477+04	7.80699+12	4.49545+12	5.17296+04	8.89352+04	2.224	1.282
1.000+02	2.01708-02	4.44477+04	7.80099+12	4.49545+12	1.48237+04	2.09784+04	2.224	1.282
5.000+02	3.25627-03	8.35777+03	1.03986+13	6.54832+12	2.55451+04	7.09343+04	2.755	1.247
5.000+02	3.25627-03	8.35777+03	1.03986+13	6.54832+12	5.34668+03	9.29765+03	2.755	1.247
2.500+03	5.40350-04	1.59574+03	1.34229+13	8.99287+12	8.26114+03	5.43621+04	3.320	1.220
2.500+03	5.40350-04	1.59574+03	1.34229+13	8.99287+12	1.81835+03	3.64571+03	3.320	1.220
1.250+04	9.21113-05	3.08240+02	1.67342+13	1.17144+13	1.96675+03	3.85402+04	3.895	1.200
1.250+04	9.21113-05	3.08240+02	1.67342+13	1.17144+13	5.53598+02	1.25758+03	3.895	1.200
6.250+04	1.62523-05	6.01645+01	2.01325+13	1.45793+13	3.88723+02	2.17180+04	4.415	1.184
6.250+04	1.62523-05	6.01645+01	2.01325+13	1.45793+13	1.55542+02	3.95403+02	4.415	1.184
3.400+05	2.73918-06	1.08899+01	2.29897+13	1.70260+13	6.15377+01	6.98638+03	4.816	1.173
3.400+05	2.73918-06	1.08899+01	2.29897+13	1.70260+13	3.47738+01	9.76103+01	4.816	1.173
2.000+06	4.51860-07	1.84185+00	2.40868+13	1.79722+13	8.22820+00	1.41297+03	4.963	1.169
2.000+06	4.51860-07	1.84185+00	2.40868+13	1.79722+13	5.84970+00	1.84815+01	4.963	1.169
1.300+07	6.90835-08	2.83065-01	2.43362+13	1.81897+13	1.23697+00	2.26744+02	4.994	1.168
1.300+07	6.90835-08	2.83065-01	2.43362+13	1.81897+13	1.05294+00	2.92924+00	4.994	1.168
1.000+08	8.97158-09	3.67920-02	2.43652+13	1.82334+13	3.49179-01	2.97911+01	4.999	1.168
1.000+08	8.97158-09	3.67920-02	2.43852+13	1.82334+13	3.36086-01	3.84091-01	4.999	1.168
8.500+08	1.05533-09	4.32838-03	2.43948+13	1.82423+13	2.27129-01	3.51492+00	5.000	1.168
8.500+08	1.05533-09	4.32838-03	2.43948+13	1.82423+13	2.25736-01	4.53051-02	5.000	1.168
8.000+09	1.12127-10	4.59889-04	2.43970+13	1.82444+13	2.05720-01	3.73787-01	5.000	1.168
8.000+09	1.12127-10	4.59889-04	2.43970+13	1.82444+13	2.05537-01	4.81773-03	5.000	1.168
8.500+10	1.05532-11	4.32836-05	2.43976+13	1.82450+13	2.00153-01	3.51897-02	5.000	1.168
8.500+10	1.05532-11	4.32836-05	2.43976+13	1.82450+13	2.00151-01	4.53558-04	5.000	1.168

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 15.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.56188-01	5.82585+05	9.88262+12	4.28723+12	2.79982+04	9.50148+04	2.638	1.377
2.000+01	1.56188-01	5.82585+05	9.88262+12	4.28723+12	1.81562+04	3.36800+04	2.638	1.377
1.000+02	2.67450-02	1.11911+05	1.34762+13	7.19924+12	2.51512+04	6.94724+04	3.081	1.311
1.000+02	2.67450-02	1.11911+05	1.34762+13	7.19924+12	1.07082+04	1.50258+04	3.081	1.311
5.000+02	4.47172-03	2.14826+04	1.76876+13	1.04810+13	1.64386+04	5.00522+04	3.685	1.272
5.000+02	4.47172-03	2.14826+04	1.76876+13	1.04810+13	4.34072+03	6.36188+03	3.685	1.272
2.500+03	7.71525-04	4.17058+03	2.19780+13	1.38690+13	5.47302+03	2.85161+04	4.272	1.246
2.500+03	7.71525-04	4.17058+03	2.19780+13	1.38690+13	1.36311+03	2.33181+03	4.272	1.246
1.250+04	1.39978-04	8.19425+02	2.52621+13	1.64806+13	1.02749+03	1.05395+04	4.709	1.232
1.250+04	1.39978-04	8.19425+02	2.52621+13	1.64806+13	3.35813+02	6.87193+02	4.709	1.232
6.250+04	2.68061-05	1.62665+02	2.67631+13	1.76602+13	1.37965+02	2.74254+03	4.918	1.227
6.250+04	2.68061-05	1.62665+02	2.67631+13	1.76602+13	6.36846+01	1.65407+02	4.918	1.227
3.400+05	4.86290-06	2.98354+01	2.72594+13	1.80559+13	1.80830+01	5.57548+02	4.983	1.225
3.400+05	4.86290-06	2.98354+01	2.72594+13	1.80559+13	1.11451+01	3.29804+01	4.983	1.225
2.000+06	8.24441-07	5.06971+00	2.74045+13	1.81801+13	2.84364+00	9.80468+01	4.997	1.224
2.000+06	8.24441-07	5.06971+00	2.74045+13	1.81801+13	2.15586+00	5.77734+00	4.997	1.224
1.300+07	1.26775-07	7.79891-01	2.74502+13	1.82219+13	6.56042-01	1.52722+01	5.000	1.224
1.300+07	1.26775-07	7.79891-01	2.74502+13	1.82219+13	5.88737-01	8.99269-01	5.000	1.224
1.000+08	1.64795-08	1.01385-01	2.74660+13	1.82372+13	2.91975-01	1.99519+00	5.000	1.224
1.000+08	1.64795-08	1.01385-01	2.74660+13	1.82372+13	2.85973-01	1.17449-01	5.000	1.224
8.500+08	1.93874-09	1.19276-02	2.74714+13	1.82425+13	2.15946-01	2.35469-01	5.000	1.224
8.500+08	1.93874-09	1.19276-02	2.74714+13	1.82425+13	2.15186-01	1.38410-02	5.000	1.224
8.000+09	2.05991-10	1.26730-03	2.74734+13	1.82444+13	2.01282-01	2.53771-02	5.000	1.224
8.000+09	2.05991-10	1.26730-03	2.74734+13	1.82444+13	2.01230-01	1.47150-03	5.000	1.224
8.500+10	1.93873-11	1.19276-04	2.74746+13	1.82457+13	1.99525-01	2.73716-03	5.000	1.224
8.500+10	1.93873-11	1.19276-04	2.74746+13	1.82457+13	1.99524-01	1.38536-04	5.000	1.224

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.24141-01	1.5088+06	1.56907+13	5.59266+12	8.27617+03	5.63231+04	3.377	1.429
2.000+01	2.24141-01	1.5088+06	1.56907+13	5.59266+12	7.31687+03	2.21301+04	3.377	1.429
1.000+02	3.93228-02	2.93299+05	2.10304+13	9.84156+12	5.67423+03	3.41081+04	3.849	1.355
1.000+02	3.93228-02	2.93299+05	2.10304+13	9.84156+12	4.58486+03	9.14558+03	3.849	1.355
5.000+02	6.94303-03	5.72425+04	2.59331+13	1.35654+13	3.12823+03	1.70458+04	4.360	1.318
5.000+02	6.94303-03	5.72425+04	2.59331+13	1.35654+13	2.01875+03	3.44707+03	4.360	1.318
2.500+03	1.27621-03	1.12756+04	2.94561+13	1.62024+13	9.38832+02	5.67650+03	4.744	1.300
2.500+03	1.27621-03	1.12756+04	2.94561+13	1.62024+13	5.51319+02	9.97085+02	4.744	1.300
1.250+04	2.47243-04	2.24282+03	3.10051+13	1.73973+13	2.03477+02	1.44656+03	4.898	1.293
1.250+04	2.47243-04	2.24282+03	3.10051+13	1.73973+13	1.22421+02	2.43327+02	4.898	1.293
6.250+04	4.87969-05	4.47562+02	3.16431+13	1.78843+13	3.76609+01	3.23736+02	4.963	1.290
6.250+04	4.87969-05	4.47562+02	3.16431+13	1.78843+13	2.58357+01	5.34691+01	4.963	1.290
3.400+05	8.91696-06	8.21909+01	3.19213+13	1.80944+13	6.72270+00	6.39464+01	4.993	1.289
3.400+05	8.91696-06	8.21909+01	3.19213+13	1.80944+13	5.21134+00	1.03631+01	4.993	1.289
2.000+06	1.51407-06	1.39697+01	3.20274+13	1.81867+13	1.32681+00	1.20014+01	4.999	1.288
2.000+06	1.51407-06	1.39697+01	3.20274+13	1.81667+13	1.16275+00	1.79939+00	4.999	1.288
1.300+07	2.32862-07	2.14907+00	3.20872+13	1.82429+13	4.07636-01	2.77341+00	5.000	1.288
1.300+07	2.32862-07	2.14907+00	3.20872+13	1.82429+13	3.91843-01	2.79993-01	5.000	1.288
1.000+08	3.02477-08	2.79341-01	3.22574+13	1.84038+13	2.32427-01	1.29569+00	5.004	1.286
1.000+08	3.02477-08	2.79341-01	3.22574+13	1.84038+13	2.31192-01	3.73785-02	5.004	1.286
8.500+08	3.53593-09	3.28289-02	3.35440+13	1.96165+13	2.03661-01	1.06759+00	5.036	1.277
8.500+08	3.53593-09	3.28289-02	3.35440+13	1.96165+13	2.03550-01	5.24013-03	5.036	1.277
8.000+09	3.59550-10	3.46324-03	4.26001+13	2.81510+13	1.99953-01	8.10752-01	5.263	1.226
8.000+09	3.59550-10	3.46324-03	4.26001+13	2.81510+13	1.99940-01	1.18633-03	5.263	1.226
8.500+10	3.07248-11	3.21161-04	6.39985+13	4.83163+13	1.99433-01	2.61063-01	5.796	1.163
8.500+10	3.07248-11	3.21161-04	6.39985+13	4.83163+13	1.99433-01	2.52377-04	5.796	1.163

NITROGEN 9/2/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	3.57516-01	4.09853+06	2.31123+13	5.91541+12	2.45993+03	2.50647+04	3.932	1.496
2.000+01	3.57516-01	4.09853+06	2.31123+13	5.91541+12	2.08671+03	1.23028+04	3.932	1.496
1.000+02	6.46076-02	8.03679+05	2.96601+13	1.09998+13	1.21245+03	1.15222+04	4.352	1.419
1.000+02	6.46076-02	8.03679+05	2.96601+13	1.09998+13	1.03475+03	4.47320+03	4.352	1.419
5.000+02	1.20471-02	1.58704+05	3.44054+13	1.46438+13	3.98670+02	3.85718+03	4.668	1.383
5.000+02	1.20471-02	1.58704+05	3.44054+13	1.46438+13	3.39551+02	1.33100+03	4.668	1.383
2.500+03	2.31979-03	3.15324+04	3.69449+13	1.65545+13	1.08262+02	1.14283+03	4.848	1.368
2.500+03	2.31979-03	3.15324+04	3.69449+13	1.65545+13	9.23629+01	3.45736+02	4.848	1.368
1.250+04	4.56311-04	6.28871+03	3.82169+13	1.75432+13	2.50681+01	3.66572+02	4.930	1.361
1.250+04	4.56311-04	6.28871+03	3.82169+13	1.75432+13	2.16595+01	7.94559+01	4.930	1.361
6.250+04	9.03040-05	1.25551+03	3.91766+13	1.83205+13	5.85023+00	1.85184+02	4.982	1.355
6.250+04	9.03040-05	1.25551+03	3.91766+13	1.83205+13	5.21418+00	1.79874+01	4.982	1.355
3.400+05	1.63670-05	2.30251+02	4.14023+13	2.02989+13	1.58829+00	1.40648+02	5.053	1.340
3.400+05	1.63670-05	2.30251+02	4.14023+13	2.02989+13	1.47548+00	4.31670+00	5.053	1.340
2.000+06	2.67008-06	3.88817+01	5.00787+13	2.82343+13	6.24507-01	1.07731+02	5.265	1.291
2.000+06	2.67008-06	3.88817+01	5.00787+13	2.82343+13	5.96249-01	1.41305+00	5.265	1.291
1.300+07	3.78325-07	5.90637+00	6.88037+13	4.53844+13	3.10682-01	5.26995+01	5.717	1.227
1.300+07	3.78325-07	5.90637+00	6.88037+13	4.53844+13	3.04759-01	4.48019-01	5.717	1.227
1.000+08	4.62507-08	7.61015-01	8.46356+13	5.99529+13	2.20109-01	2.01114+01	6.080	1.194
1.000+08	4.62507-08	7.61015-01	8.46356+13	5.99529+13	2.19513-01	8.80744-02	6.080	1.194
8.500+08	5.04344-09	8.86065-02	1.07834+14	8.14797+13	2.02959-01	7.58034+00	6.559	1.163
8.500+08	5.04344-09	8.86065-02	1.07834+14	8.14797+13	2.02872-01	1.68754-02	6.559	1.163
8.000+09	5.07636-10	9.34883-03	1.25715+14	9.80690+13	1.99833-01	1.26240+00	6.924	1.146
8.000+09	5.07636-10	9.34883-03	1.25715+14	9.80890+13	1.99814-01	2.34058-03	6.924	1.146
8.500+10	4.73097-11	8.78803-04	1.29076+14	1.01211+14	1.99394-01	1.26955-01	6.992	1.144
8.500+10	4.73097-11	8.78803-04	1.29076+14	1.01211+14	1.99390-01	2.30019-04	6.992	1.144

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	7.40490-02	5.27802+03	1.80525+11	7.36019+10	4.70931+04	7.90593+04	0.339	1.395
2.000+01	7.40490-02	5.27802+03	1.80525+11	7.36019+10	2.31159+04	6.01543+04	0.339	1.395
1.000+02	9.67244-03	7.82106+02	2.53031+11	1.31735+11	3.19835+04	4.84492+04	0.519	1.320
1.000+02	9.67244-03	7.82106+02	2.53031+11	1.31735+11	1.37277+04	3.28872+04	0.519	1.320
5.000+02	1.29342-03	1.22292+02	3.41774+11	1.99940+11	1.78835+04	2.64023+04	0.776	1.277
5.000+02	1.29342-03	1.22292+02	3.41774+11	1.99940+11	6.69528+03	1.59758+04	0.776	1.277
2.500+03	2.11804-04	2.19627+01	4.09634+11	2.54084+11	7.15454+03	1.25748+04	0.948	1.253
2.500+03	2.11804-04	2.19627+01	4.09634+11	2.54084+11	2.26892+03	5.41374+03	0.948	1.253
1.250+04	3.80256-05	4.16175+00	4.70098+11	3.05918+11	2.31248+03	7.51524+03	1.056	1.233
1.250+04	3.80256-05	4.16175+00	4.70098+11	3.05918+11	7.10690+02	1.74657+03	1.056	1.233
6.250+04	6.39674-06	7.68019-01	6.06131+11	4.26024+11	7.76011+02	5.18463+03	1.255	1.198
6.250+04	6.39674-06	7.68019-01	6.06131+11	4.26024+11	2.59114+02	7.16297+02	1.255	1.198
3.400+05	8.99835-07	1.26485-01	8.73940+11	6.63080+11	2.11508+02	2.57142+03	1.640	1.161
3.400+05	8.99835-07	1.26485-01	8.73940+11	6.63080+11	8.31600+01	2.70987+02	1.640	1.161
2.000+06	1.30987-07	2.03319-02	1.06831+12	8.35465+11	3.82634+01	8.60477+02	1.916	1.145
2.000+06	1.30987-07	2.03319-02	1.06831+12	8.35465+11	1.91811+01	6.49406+01	1.916	1.145
1.300+07	1.91026-08	3.07213-03	1.15420+12	9.12951+11	6.03600+00	3.82405+02	2.021	1.139
1.300+07	1.91026-08	3.07213-03	1.15420+12	9.12951+11	3.88888+00	1.15808+01	2.021	1.139
1.000+08	2.26055-09	3.87517-04	1.36515+12	1.10800+12	1.14554+00	2.44306+02	2.220	1.126
1.000+08	2.26055-09	3.87517-04	1.36515+12	1.10800+12	9.32446-01	2.10332+00	2.220	1.126
8.500+08	2.18100-10	4.30429-05	1.89190+12	1.59565+12	3.64443-01	8.86531+01	2.707	1.104
8.500+08	2.18100-10	4.30429-05	1.89190+12	1.59565+12	3.41560-01	4.24300-01	2.707	1.104
8.000+09	2.12088-11	4.46874-06	2.16337+12	1.84730+12	2.25788-01	1.27191+01	2.958	1.097
8.000+09	2.12088-11	4.46874-06	2.16337+12	1.84730+12	2.23548-01	5.48151-02	2.958	1.097
8.500+10	1.97075-12	4.19237-07	2.20463+12	1.88552+12	1.96971-01	1.24473+00	2.996	1.096
8.500+10	1.97075-12	4.19237-07	2.20463+12	1.88552+12	1.96829-01	5.30010-03	2.996	1.096

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	6.58344-02	8.93845+03	4.00113+11	1.96442+11	5.07673+04	8.23383+04	0.700	1.339
2.000+01	6.58344-02	8.93845+03	4.00113+11	1.96442+11	2.81185+04	5.81444+04	0.700	1.339
1.000+02	1.06552-02	1.58712+03	5.13754+11	2.90311+11	3.46047+04	4.74865+04	0.865	1.290
1.000+02	1.06552-02	1.58712+03	5.13754+11	2.90311+11	1.56957+04	2.40529+04	0.865	1.290
5.000+02	1.67730-03	2.81190+02	6.58253+11	4.06771+11	2.05632+04	3.36686+04	1.099	1.255
5.000+02	1.67730-03	2.81190+02	6.58253+11	4.06771+11	7.53141+03	1.19340+04	1.099	1.255
2.500+03	2.63240-04	5.04707+01	8.55013+11	5.67401+11	1.12454+04	2.27008+04	1.401	1.224
2.500+03	2.63240-04	5.04707+01	8.55013+11	5.67401+11	3.10651+03	5.52535+03	1.401	1.224
1.250+04	4.18382-05	9.23093+00	1.10542+12	7.74447+11	4.39330+03	1.30955+04	1.763	1.200
1.250+04	4.18382-05	9.23093+00	1.10542+12	7.74447+11	1.15548+03	2.21847+03	1.763	1.200
6.250+04	7.29542-06	1.76056+00	1.31444+12	9.52432+11	1.15280+03	7.64783+03	2.022	1.184
6.250+04	7.29542-06	1.76056+00	1.31444+12	9.52432+11	3.76050+02	6.79748+02	2.022	1.184
3.400+05	1.16478-06	3.09555-01	1.63020+12	1.23153+12	2.47376+02	4.56366+03	2.328	1.163
3.400+05	1.16478-06	3.09555-01	1.63020+12	1.23153+12	1.01647+02	2.00263+02	2.328	1.163
2.000+06	1.67993-07	5.02271-02	2.08447+12	1.63597+12	4.02329+01	1.67826+03	2.744	1.143
2.000+06	1.67993-07	5.02271-02	2.08447+12	1.63597+12	2.11428+01	5.31216+01	2.744	1.143
1.300+07	2.40485-08	7.58378-03	2.31093+12	1.83767+12	5.41208+00	3.32007+02	2.949	1.136
1.300+07	2.40485-08	7.58378-03	2.31093+12	1.83767+12	3.71342+00	9.74048+00	2.949	1.136
1.000+08	3.08037-09	9.82223-04	2.36039+12	1.88206+12	8.61197-01	4.54817+01	2.993	1.135
1.000+08	3.08037-09	9.82223-04	2.36039+12	1.88206+12	7.45689-01	1.31720+00	2.993	1.135
8.500+08	3.61652-10	1.15496-04	2.36766+12	1.88859+12	2.95959-01	5.40092+00	2.999	1.135
8.500+08	3.61652-10	1.15496-04	2.36766+12	1.88859+12	2.88974-01	1.56146-01	2.999	1.135
8.000+09	3.84160-11	1.22707-05	2.36866+12	1.88951+12	2.08345-01	5.74947-01	3.000	1.135
8.000+09	3.84160-11	1.22707-05	2.36866+12	1.88951+12	2.07947-01	1.66188-02	3.000	1.135
8.500+10	3.61553-12	1.15488-06	2.36881+12	1.88965+12	1.94426-01	5.41386-02	3.000	1.135
8.500+10	3.61553-12	1.15488-06	2.36881+12	1.88965+12	1.94413-01	1.56484-03	3.000	1.135

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 3.400

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	7.80310-02	1.97491+04	6.86478+11	3.06814+11	4.06292+04	7.68835+04	1.097	1.369
2.000+01	7.80310-02	1.97491+04	6.86478+11	3.06814+11	2.17046+04	5.04174+04	1.097	1.369
1.000+02	1.30015-02	3.63552+03	9.73585+11	5.54125+11	3.41107+04	4.82360+04	1.317	1.287
1.000+02	1.30015-02	3.63552+03	9.73585+11	5.54125+11	1.34869+04	2.06180+04	1.317	1.287
5.000+02	2.09962-03	6.66686+02	1.25696+12	7.82640+11	2.61163+04	3.39785+04	1.631	1.252
5.000+02	2.09962-03	6.66686+02	1.25696+12	7.82640+11	7.51201+03	9.80965+03	1.631	1.252
2.500+03	3.31692-04	1.22690+02	1.62675+12	1.07188+12	1.41361+04	2.41848+04	2.065	1.227
2.500+03	3.31692-04	1.22690+02	1.62675+12	1.07168+12	3.48499+03	4.45063+03	2.065	1.227
1.250+04	5.46436-05	2.31268+01	2.06299+12	1.42810+12	4.27399+03	1.30947+04	2.507	1.205
1.250+04	5.46436-05	2.31268+01	2.06299+12	1.42810+12	1.18019+03	1.67132+03	2.507	1.205
6.250+04	9.66443-06	4.47280+00	2.41465+12	1.72039+12	8.31171+02	4.42032+03	2.835	1.192
6.250+04	9.66443-06	4.47280+00	2.41465+12	1.72039+12	3.06900+02	4.93165+02	2.835	1.192
3.400+05	1.69979-06	8.12943-01	2.56142+12	1.84399+12	1.25149+02	9.86403+02	2.963	1.187
3.400+05	1.69979-06	8.12943-01	2.56142+12	1.84399+12	6.31502+01	1.06216+02	2.963	1.187
2.000+06	2.86065-07	1.37850-01	2.60062+12	1.87774+12	1.77063+01	1.78319+02	2.993	1.185
2.000+06	2.86065-07	1.37850-01	2.60062+12	1.87774+12	1.14497+01	1.90617+01	2.993	1.185
1.300+07	4.39280-08	2.11978-02	2.61016+12	1.88628+12	2.58948+00	2.80041+01	2.999	1.185
1.300+07	4.39280-08	2.11978-02	2.61016+12	1.88628+12	2.03259+00	2.98951+00	2.999	1.185
1.000+08	5.70892-09	2.75551-03	2.61270+12	1.88865+12	5.25664-01	3.66871+00	3.000	1.185
1.000+08	5.70892-09	2.75551-03	2.61270+12	1.88865+12	4.79951-01	3.91455-01	3.000	1.185
8.500+08	6.71610-10	3.24175-04	2.61344+12	1.88937+12	2.41801-01	4.33762-01	3.000	1.185
8.500+08	6.71610-10	3.24175-04	2.61344+12	1.88937+12	2.37970-01	4.61724-02	3.000	1.185
8.000+09	7.13577-11	3.44435-05	2.61376+12	1.88968+12	1.98167-01	4.71677-02	3.000	1.185
8.000+09	7.13577-11	3.44435-05	2.61376+12	1.88968+12	1.97979-01	4.91053-03	3.000	1.185
8.500+10	6.71552-12	3.24168-06	2.61480+12	1.89069+12	1.92779-01	5.49387-03	3.000	1.185
8.500+10	6.71552-12	3.24168-06	2.61480+12	1.89069+12	1.92774-01	4.62657-04	3.000	1.185

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	9.62458-02	4.41787+04	1.14928+12	4.60704+11	1.74359+04	6.56051+04	1.587	1.399
2.000+01	9.62458-02	4.41787+04	1.14928+12	4.60704+11	1.31856+04	4.17288+04	1.587	1.399
1.000+02	1.72994-02	8.48975+03	1.55665+12	8.20473+11	1.35538+04	3.74967+04	1.765	1.315
1.000+02	1.72994-02	8.48975+03	1.55665+12	8.20473+11	9.07746+03	1.62853+04	1.765	1.315
5.000+02	2.79103-03	1.57926+03	2.05586+12	1.20706+12	8.71940+03	2.22629+04	2.189	1.275
5.000+02	2.79103-03	1.57926+03	2.05586+12	1.20706+12	4.92261+03	7.12417+03	2.189	1.275
2.500+03	4.64881-04	2.99290+02	2.51404+12	1.54828+12	3.68230+03	1.02087+04	2.628	1.256
2.500+03	4.64881-04	2.99290+02	2.51404+12	1.54828+12	1.91596+03	2.65931+03	2.628	1.256
1.250+04	8.46321-05	5.83773+01	2.76721+12	1.75248+12	9.89724+02	3.18238+03	2.887	1.247
1.250+04	8.46321-05	5.83773+01	2.76721+12	1.75248+12	5.52192+02	7.78586+02	2.887	1.247
6.250+04	1.64355-05	1.15883+01	2.89580+12	1.83811+12	2.03138+02	7.60624+02	2.973	1.243
6.250+04	1.64355-05	1.15883+01	2.89580+12	1.83811+12	1.28972+02	1.82706+02	2.973	1.243
3.400+05	2.99947-06	2.12635+00	2.93393+12	1.87051+12	3.51089+01	1.51988+02	2.995	1.242
3.400+05	2.99947-06	2.12635+00	2.93393+12	1.87051+12	2.55557+01	3.59551+01	2.995	1.242
2.000+06	5.09104-07	3.61336-01	2.94684+12	1.88414+12	5.66650+00	2.84463+01	3.000	1.241
2.000+06	5.09104-07	3.61336-01	2.94684+12	1.88414+12	4.69194+00	6.30006+00	3.000	1.241
1.300+07	7.82376-08	5.55749-02	2.96512+12	1.89955+12	1.01678+00	6.29837+00	3.003	1.240
1.300+07	7.82376-08	5.55749-02	2.96512+12	1.89955+12	9.39217-01	9.89504-01	3.003	1.240
1.000+08	1.01051-08	7.21307-03	3.05484+12	1.98407+12	3.14986-01	2.70464+00	3.022	1.234
1.000+08	1.01051-08	7.21307-03	3.05484+12	1.98407+12	3.07993-01	1.37650-01	3.022	1.234
8.500+08	1.13608-09	8.39235-04	3.69037+12	2.58224+12	2.13031-01	1.92902+00	3.163	1.200
8.500+08	1.13608-09	8.39235-04	3.69037+12	2.58224+12	2.11909-01	2.33515-02	3.163	1.200
8.000+09	1.04686-10	8.63253-05	5.88099+12	4.64400+12	1.96451-01	8.22240-01	3.647	1.140
8.000+09	1.04686-10	8.63253-05	5.88099+12	4.64400+12	1.96335-01	5.09899-03	3.647	1.140
8.500+10	9.08120-12	7.98781-06	7.28945+12	5.96997+12	1.92745-01	1.53968-01	3.957	1.121
8.500+10	9.08120-12	7.98781-06	7.28945+12	5.96997+12	1.92736-01	6.40436-04	3.957	1.121

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 7.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.25488-01	9.40222+04	1.65020+12	5.26247+11	6.50374+03	4.35539+04	2.016	1.454
2.000+01	1.25486-01	9.40222+04	1.65020+12	5.26247+11	5.66562+03	3.07516+04	2.016	1.454
1.000+02	2.36510-02	1.84450+04	2.17207+12	1.00217+12	3.72520+03	2.13765+04	2.139	1.359
1.000+02	2.36510-02	1.84450+04	2.17207+12	1.00217+12	3.22237+03	1.10654+04	2.139	1.359
5.000+02	3.98679-03	3.50431+03	2.71060+12	1.39205+12	1.79874+03	9.78690+05	2.538	1.324
5.000+02	3.98679-03	3.50431+03	2.71060+12	1.39205+12	1.51679+03	4.18916+03	2.538	1.324
2.500+03	7.23310-04	6.82466+02	3.07838+12	1.66299+12	5.64175+02	3.25752+03	2.798	1.307
2.500+03	7.23310-04	6.82466+02	3.07838+12	1.66299+12	4.73435+02	1.24963+03	2.798	1.307
1.250+04	1.37226-04	1.34646+02	3.27507+12	1.80319+12	1.51063+02	9.79498+02	2.949	1.300
1.250+04	1.37226-04	1.34646+02	3.27507+12	1.80319+12	1.28176+02	3.26291+02	2.949	1.300
6.250+04	2.69586-05	2.68083+01	3.40118+12	1.90945+12	3.84092+01	3.39553+02	3.003	1.292
6.250+04	2.69586-05	2.68083+01	3.40118+12	1.90945+12	3.24310+01	7.55313+01	3.003	1.292
2.400+05	4.84795-06	4.90124+00	3.69358+12	2.17700+12	1.11636+01	1.82159+02	3.069	1.274
3.400+05	4.84795-06	4.90124+00	3.69358+12	2.17700+12	9.21329+00	1.71350+01	3.069	1.274
2.000+06	7.64973-07	8.18509-01	4.79525+12	3.19018+12	3.74451+00	1.18424+02	3.307	1.223
2.000+06	7.64973-07	8.18509-01	4.79525+12	3.19018+12	3.03674+00	4.81950+00	3.307	1.223
1.300+07	1.03898-07	1.22498-01	6.83631+12	5.06766+12	1.04987+00	5.00205+01	3.746	1.172
1.300+07	1.03898-07	1.22498-01	6.83631+12	5.06766+12	8.96226-01	1.28851+00	3.746	1.172
1.000+08	1.26341-08	1.57080-02	8.09029+12	6.22522+12	3.40038-01	1.71591+01	4.004	1.154
1.000+08	1.26341-08	1.57080-02	8.09029+12	6.22522+12	3.18424-01	2.16754-01	4.004	1.154
8.500+08	1.38519-09	1.82286-03	9.77417+12	7.80010+12	2.19392-01	8.79604+00	4.297	1.135
8.500+08	1.38519-09	1.82286-03	9.77417+12	7.80010+12	2.15166-01	3.62694-02	4.297	1.135
8.000+09	1.31479-10	1.89779-04	1.28161+13	1.06508+13	1.97001-01	2.90141+00	4.810	1.113
8.000+09	1.31479-10	1.89779-04	1.28161+13	1.06508+13	1.96323-01	6.01382-03	4.810	1.113
8.500+10	1.17668-11	1.77106-05	1.43876+13	1.21298+13	1.92728-01	9.62726-01	5.058	1.105
8.500+10	1.17668-11	1.77106-05	1.43876+13	1.21298+13	1.92708-01	6.86782-04	5.058	1.105

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 10.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.84075-01	2.18627+05	2.33299+12	5.51316+11	2.91055+03	2.60274+04	2.346	1.509
2.000+01	1.84075-01	2.18627+05	2.33299+12	5.51316+11	2.17219+03	1.91819+04	2.346	1.509
1.000+02	3.44179-02	4.28747+04	3.02318+12	1.15450+12	1.21726+03	1.11252+04	2.510	1.412
1.000+02	3.44179-02	4.28747+04	3.02318+12	1.15450+12	9.06418+02	6.00673+03	2.510	1.412
5.000+02	6.29681-03	8.36668+03	3.61507+12	1.62187+12	5.44935+02	5.52963+03	2.744	1.368
5.000+02	6.29681-03	8.36668+03	3.61507+12	1.62187+12	4.02039+02	2.08966+03	2.744	1.368
2.500+03	1.16385-03	1.63944+03	4.30924+12	2.19616+12	2.29540+02	3.18457+03	2.969	1.327
2.500+03	1.16385-03	1.63944+03	4.30924+12	2.19616+12	1.65795+02	6.82480+03	2.969	1.327
1.250+04	2.08571-04	3.19299+02	5.64927+12	3.35279+12	1.12778+02	2.11670+03	3.313	1.271
1.250+04	2.08571-04	3.19299+02	5.64927+12	3.35279+12	8.00434+01	2.53371+02	3.313	1.271
6.250+04	3.70944-05	6.22201+01	7.53808+12	5.02190+12	4.59736+01	1.16064+03	3.726	1.223
6.250+04	3.70944-05	6.22201+01	7.53808+12	5.02190+12	3.27880+01	8.82009+01	3.726	1.223
3.400+05	6.26659-06	1.12415+01	9.21813+12	6.52713+12	1.40263+01	5.95905+02	4.054	1.195
3.400+05	6.26659-06	1.12415+01	9.21813+12	6.52713+12	1.04652+01	2.37609+01	4.054	1.195
2.000+06	9.69967-07	1.87722+00	1.15775+13	8.67432+12	3.81716+00	3.25029+02	4.453	1.167
2.000+06	9.69967-07	1.87722+00	1.15775+13	8.67432+12	3.06803+00	6.23855+00	4.453	1.167
1.300+07	1.35647-07	2.83984-01	1.43489+13	1.12084+13	9.30644-01	1.44096+02	4.899	1.146
1.300+07	1.35647-07	2.83984-01	1.43489+13	1.12084+13	8.22549-01	1.39331+00	4.899	1.146
1.000+08	1.63302-08	3.64515-02	1.71222+13	1.37717+13	3.24322-01	7.03694+01	5.293	1.130
1.000+08	1.63302-08	3.64515-02	1.71222+13	1.37717+13	3.14114-01	2.52027-01	5.293	1.130
8.500+08	1.74496-09	4.22628-03	2.11161+13	1.74829+13	2.16610-01	2.81269+01	5.824	1.115
8.500+08	1.74496-09	4.22628-03	2.11161+13	1.74829+13	2.15507-01	4.29431-02	5.824	1.115
8.000+09	1.73752-10	4.44908-04	2.43606+13	2.05194+13	1.96045-01	1.23810+01	6.215	1.105
8.000+09	1.73752-10	4.44908-04	2.43606+13	2.05194+13	1.95915-01	5.92773-03	6.215	1.105
8.500+10	1.49702-11	4.13829-05	2.95318+13	2.53850+13	1.92760-01	4.60894+00	6.789	1.094
8.500+10	1.49702-11	4.13829-05	2.95318+13	2.53850+13	1.92756-01	7.87607-04	6.789	1.094

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 15.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.87154-01	5.75308+05	4.18588+12	1.18047+12	3.21422+03	2.37807+04	2.763	1.479
2.000+01	2.87154-01	5.75308+05	4.18588+12	1.18047+12	1.71270+03	1.25894+04	2.763	1.479
1.000+02	5.38419-02	1.13151+05	5.63583+12	2.48833+12	1.53634+03	1.42269+04	2.947	1.373
1.000+02	5.38419-02	1.13151+05	5.63583+12	2.48833+12	8.12266+02	4.72066+03	2.947	1.373
5.000+02	9.23049-03	2.18115+04	7.86607+12	4.32138+12	9.12633+02	9.77908+03	3.439	1.300
5.000+02	9.23049-03	2.18115+04	7.86607+12	4.32136+12	4.77165+02	2.03220+03	3.439	1.300
2.500+03	1.60868-03	4.23590+03	1.04383+13	6.48629+12	4.36909+02	6.38451+03	3.946	1.252
2.500+03	1.60868-03	4.23590+03	1.04383+13	6.48629+12	2.35468+02	7.82190+02	3.946	1.252
1.250+04	2.84537-04	8.27375+02	1.34564+13	9.09447+12	1.64316+02	4.05573+03	4.462	1.216
1.250+04	2.84537-04	8.27375+02	1.34564+13	9.09447+12	9.81430+01	2.80344+02	4.462	1.216
6.250+04	5.08960-05	1.62275+02	1.67800+13	1.19972+13	5.49320+01	2.49053+03	4.989	1.190
6.250+04	5.08960-05	1.62275+02	1.67800+13	1.19972+13	3.71713+01	9.11006+01	4.989	1.190
3.400+05	8.44303-06	2.93439+01	2.07266+13	1.55130+13	1.56276+01	1.46691+03	5.528	1.168
3.400+05	8.44303-06	2.93439+01	2.07266+13	1.55130+13	1.06849+01	2.61020+01	5.528	1.168
2.000+06	1.30941-06	4.92144+00	2.50762+13	1.94381+13	3.70007+00	8.06573+02	6.060	1.150
2.000+06	1.30941-06	4.92144+00	2.50762+13	1.94381+13	2.78466+00	6.44896+00	6.060	1.150
1.300+07	1.84147-07	7.47934-01	3.02910+13	2.41982+13	8.36442-01	4.30879+02	6.629	1.134
1.300+07	1.84147-07	7.47934-01	3.02910+13	2.41982+13	7.35056-01	1.42533+00	6.629	1.134
1.000+08	2.20454-08	9.62233-02	3.59996+13	2.94520+13	3.11124-01	2.16890+02	7.199	1.121
1.000+08	2.20454-08	9.62233-02	3.59996+13	2.94520+13	2.98625-01	2.55909-01	7.199	1.121
8.500+08	2.38428-09	1.12090-02	4.29820+13	3.59298+13	2.14958-01	1.04963+02	7.831	1.109
8.500+08	2.38428-09	1.12090-02	4.29820+13	3.59298+13	2.12806-01	4.17097-02	7.831	1.109
8.000+09	2.35075-10	1.18123-03	5.03910+13	4.28531+13	1.96057-01	5.16942+01	8.439	1.100
8.000+09	2.35075-10	1.18123-03	5.03910+13	4.28531+13	1.95698-01	5.92387-03	8.439	1.100
8.500+10	2.05756-11	1.10350-04	5.87433+13	5.06980+13	1.92727-01	2.35481+01	9.074	1.091
8.500+10	2.05756-11	1.10350-04	5.87433+13	5.06980+13	1.92695-01	7.32963-04	9.074	1.091

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.0[illegible]+01	3.99925-01	1.48346+06	9.28002+12	3.71567+12	8.66173+03	2.79802+04	3.645	1.400
2.0[illegible]+01	3.99925-01	1.48346+06	9.28002+12	3.71567+12	3.12012+03	1.16907+04	3.645	1.400
1.600+02	7.41114-02	2.92001+05	1.23914+13	6.48096+12	4.21765+03	1.85604+04	3.934	1.318
1.600+02	7.41114-02	2.92001+05	1.23914+13	6.48096+12	1.55132+03	4.59341+03	3.934	1.318
5.000+02	1.26966-02	5.67027+04	1.68581+13	1.01587+13	1.80369+03	1.36107+04	4.593	1.265
5.000+02	1.26966-02	5.67027+04	1.68581+13	1.01587+13	7.01582+02	1.96717+03	4.593	1.265
1.500+03	2.20672-03	1.10749+04	2.20359+13	1.45073+13	6.11455+02	9.64476+03	5.285	1.228
2.500+03	2.20672-03	1.10749+04	2.20359+13	1.45073+13	2.63969+02	7.62149+02	5.285	1.228
1.250+04	3.90166-04	2.17412+03	2.78200+13	1.94610+13	1.90863+02	6.62873+03	5.978	1.200
1.250+04	3.90166-04	2.17412+03	2.78200+13	1.94610+13	1.08305+02	2.69099+02	5.978	1.200
6.250+04	6.99473-05	4.28367+02	3.43168+13	2.51300+13	5.86695+01	4.40723+03	6.669	1.178
6.250+04	6.99473-05	4.28367+02	3.43168+13	2.51300+13	3.22346+01	8.63225+01	6.669	1.178
3.400+05	1.16102-05	7.77475+01	4.17126+13	3.16672+13	1.48401+01	2.85202+03	7.386	1.161
3.400+05	1.16102-05	7.77475+01	4.17126+13	3.16672+13	9.54378+00	2.43795+01	7.366	1.161
2.000+06	1.79943-06	1.30779+01	5.01177+13	3.92154+13	3.22187+00	1.74572+03	8.101	1.145
2.000+06	1.79943-06	1.30779+01	5.01177+13	3.92154+13	2.30590+00	6.01759+00	8.101	1.145
1.300+07	2.53952-07	1.99371+00	5.96507+13	4.78739+13	7.63568-01	1.01114+03	8.831	1.132
1.300+07	2.53952-07	1.99371+00	5.96507+13	4.78739+13	6.31148-01	1.29629+00	8.831	1.132
1.000+08	3.04201-08	2.57111-01	7.04362+13	5.77574+13	2.96621-01	5.25968+02	9.584	1.120
1.000+08	3.04201-08	2.57111-01	7.04362+13	5.77574+13	2.78967-01	2.30663-01	9.584	1.120
8.500+08	3.33195-09	3.00512-02	8.14484+13	6.79189+13	2.11613-01	2.23103+02	10.294	1.111
8.500+08	3.33195-09	3.00512-02	8.14484+13	6.79189+13	2.08958-01	3.55287-02	10.294	1.111
8.000+09	3.36094-10	3.17862-03	9.04093+13	7.62221+13	1.95060-01	4.73675+01	10.843	1.105
8.000+09	3.36094-10	3.17862-03	9.04093+13	7.62221+13	1.94755-01	4.55347-03	10.843	1.105
8.500+10	3.12296-11	2.98843-04	9.27128+13	7.83580+13	1.92490-01	5.07294+00	10.983	1.103
8.500+10	3.12296-11	2.98843-04	9.27128+13	7.83580+13	1.92479-01	4.47718-04	10.983	1.103

ALUMINUM 9/2/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(G*/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	5.80247-01	3.96779+06	1.81905+13	7.93274+12	1.39098+04	2.83959+04	4.667	1.376
2.000+01	5.80247-01	3.96779+06	1.81905+13	7.93274+12	4.25447+03	9.44032+03	4.667	1.376
1.000+02	1.03626-01	7.78567+05	2.47617+13	1.34911+13	6.26618+03	2.66451+04	5.226	1.303
1.000+02	1.03626-01	7.78567+05	2.47617+13	1.34911+13	1.66671+03	4.64801+03	5.226	1.303
5.000+02	1.77441-02	1.52116+05	3.35332+13	2.06733+13	2.31897+03	1.56306+04	6.104	1.256
5.000+02	1.77441-02	1.52116+05	3.35332+13	2.06733+13	6.65524+02	1.69452+03	6.104	1.256
2.500+03	3.09791-03	2.98791+04	4.31526+13	2.86843+13	7.35641+02	1.19016+04	6.993	1.224
2.500+03	3.09791-03	2.98791+04	4.31526+13	2.86843+13	2.46541+02	6.53691+02	6.993	1.224
1.250+04	5.48749-04	5.89034+03	5.38636+13	3.77614+13	2.20758+02	8.64652+03	7.895	1.199
1.250+04	5.48748-04	5.89034+03	5.38636+13	3.77614+13	8.40274+01	2.28242+02	7.895	1.199
6.250+04	9.86846-05	1.16493+03	6.53946+13	4.77189+13	5.85118+01	5.85035+03	8.765	1.180
6.250+04	9.86846-05	1.16493+03	6.53946+13	4.77189+13	2.63834+01	7.19129+01	8.765	1.180
3.400+05	1.65536-05	2.12193+02	7.78424+13	5.86192+13	1.15334+01	3.45681+03	9.619	1.165
3.400+05	1.65536-05	2.12193+02	7.78424+13	5.86192+13	7.07632+00	1.93895+01	9.619	1.165
2.000+06	2.60988-06	3.38454+01	8.97611+13	6.91696+13	2.16887+00	1.53989+03	10.375	1.153
2.000+06	2.60988-06	3.38454+01	8.97611+13	6.91696+13	1.67266+00	4.47925+00	10.375	1.153
1.300+07	3.84131-07	5.49061+00	9.76485+13	7.62968+13	5.10219-01	3.79162+02	10.845	1.146
1.300+07	3.84131-07	5.49061+00	9.76485+13	7.62968+13	4.56285-01	8.16927-01	10.845	1.146
1.000+08	4.95351-08	7.13053-01	9.99268+13	7.82455+13	2.39925-01	5.52419+01	10.977	1.145
1.000+08	4.95351-08	7.13053-01	9.99268+13	7.82455+13	2.36756-01	1.11401-01	10.977	1.145
8.500+08	5.79363-09	8.38759-02	1.00283+14	7.85654+13	1.99196-01	6.61781+00	10.997	1.144
8.500+08	5.79363-09	8.38759-02	1.00283+14	7.85654+13	1.96751-01	1.32215-02	10.997	1.144
8.000+09	6.15437-10	8.91165-03	1.00331+14	7.86090+13	1.93570-01	7.05147-0.	11.000	1.144
8.000+09	6.15437-10	8.91165-03	1.00331+14	7.86090+13	1.93475-01	1.40720-03	11.000	1.144
8.500+10	5.79221-11	8.38742-04	1.00337+14	7.86154+13	1.92461-01	6.64922-02	11.000	1.144
8.500+10	5.79221-11	8.38742-04	1.00337+14	7.86154+13	1.92457-01	1.32497-04	11.000	1.144

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 1.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.17732-01	7.35590+03	1.54759+11	6.10330+10	1.00599+04	5.80927+04	0.222	1.404
2.000+01	1.17732-01	7.35590+03	1.54759+11	6.10330+10	5.02155+03	4.27055+04	0.222	1.404
1.000+02	1.42637-02	9.96526+02	2.16626+11	1.12023+11	9.17965+03	4.13645+04	0.366	1.322
1.000+02	1.42637-02	9.96526+02	2.16626+11	1.12023+11	4.12328+03	2.73481+04	0.366	1.322
5.000+02	1.61546-03	1.36038+02	3.11073+11	1.84750+11	7.20876+03	2.53785+04	0.647	1.271
5.000+02	1.61546-03	1.36038+02	3.11073+11	1.84750+11	2.64489+03	1.55800+04	0.647	1.271
2.500+03	2.35470-04	2.27273+01	3.98478+11	2.53691+11	5.07995+03	1.20429+04	0.888	1.242
2.500+03	2.35470-04	2.27273+01	3.98478+11	2.53691+11	1.16023+03	5.78446+03	0.888	1.242
1.250+04	4.10110-05	4.23441+00	4.59065+11	3.04179+11	2.33032+03	6.46495+03	1.019	1.225
1.250+04	4.10110-05	4.23441+00	4.59065+11	3.04179+11	4.01640+02	1.79072+03	1.019	1.225
6.250+04	7.05120-06	7.88027-01	5.61700+11	3.94053+11	7.64579+02	4.34793+03	1.186	1.199
6.250+04	7.05120-06	7.88027-01	5.61700+11	3.94053+11	1.55579+02	6.67818+02	1.186	1.199
3.400+05	9.93094-07	1.29360-01	7.95797+11	6.00395+11	1.99055+02	2.30149+03	1.547	1.164
3.400+05	9.93094-07	1.29360-01	7.95797+11	6.00395+11	6.02400+01	2.61736+02	1.547	1.164
2.000+06	1.39400-07	2.04866-02	1.00895+12	7.88490+11	3.47761+01	6.71611+02	1.874	1.146
2.000+06	1.39400-07	2.04866-02	1.00895+12	7.88490+11	1.57071+01	6.75522+01	1.874	1.146
1.300+07	2.02720-08	3.09174-03	1.08254+12	8.53761+11	4.91361+00	1.57143+02	1.983	1.141
1.300+07	2.02720-08	3.09174-03	1.08254+12	8.53761+11	3.10314+00	1.17523+01	1.983	1.141
1.000+08	2.57072-09	3.98621-04	1.13206+12	8.99453+11	9.09040-01	6.13820+01	2.032	1.137
1.000+08	2.57072-09	3.98621-04	1.13206+12	8.99453+11	7.55854-01	1.67640+00	2.032	1.137
8.500+08	2.74788-10	4.54828-05	1.37473+12	1.12644+12	3.39994-01	3.89957+01	2.237	1.120
8.500+08	2.74788-10	4.54828-05	1.37473+12	1.12644+12	3.26427-01	2.85210-01	2.237	1.120
8.000+09	2.37889-11	4.55605-06	1.98117+12	1.69367+12	2.27212-01	1.33538+01	2.745	1.097
8.000+09	2.37889-11	4.55605-06	1.98117+12	1.69367+12	2.25679-01	5.36609-02	2.745	1.097
8.500+10	2.06803-12	4.20065-07	2.25319+12	1.94849+12	2.04088-01	2.57017+00	2.972	1.090
8.500+10	2.06803-12	4.20065-07	2.25319+12	1.94849+12	2.03847-01	6.04613-03	2.972	1.090

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 2.250

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KRLK(CM2/GM)	ZBAR	EGAM
2.000+01	8.19208-02	9.96454+03	3.53080+11	1.70614+11	5.25834+04	7.17655+04	0.586	1.345
2.000+01	8.19208-02	9.96454+03	3.53080+11	1.70614+11	2.24730+04	5.13470+04	0.586	1.345
1.000+02	1.25238-02	1.69681+03	4.76507+11	2.73263+11	3.91861+04	4.33207+04	0.766	1.284
1.000+02	1.25238-02	1.69681+03	4.76507+11	2.73263+11	1.25323+04	2.36301+04	0.766	1.284
5.000+02	1.87501-03	2.91061+02	6.12518+11	3.79655+11	2.48713+04	3.01868+04	1.024	1.253
5.000+02	1.87501-03	2.91061+02	6.12518+11	3.79655+11	6.29500+03	1.16435+04	1.024	1.253
2.500+03	2.92199-04	5.18612+01	7.95618+11	5.29573+11	1.20529+04	2.00275+04	1.314	1.223
2.500+03	2.92199-04	5.18612+01	7.95618+11	5.29573+11	2.67886+03	5.33843+03	1.314	1.223
1.250+04	4.56714-05	9.39291+00	1.04520+12	7.36688+11	3.97861+03	1.06177+04	1.681	1.197
1.250+04	4.56714-05	9.39291+00	1.04520+12	7.36668+11	1.06010+03	2.22132+03	1.681	1.197
6.250+04	7.93226-06	1.78639+00	1.23412+12	8.96289+11	1.01680+03	4.84213+03	1.936	1.182
6.250+04	7.93226-06	1.78639+00	1.23412+12	8.96289+11	3.23126+02	6.61858+02	1.936	1.182
3.400+05	1.32992-06	3.18545-01	1.42075+12	1.06144+12	2.00830+02	2.72106+03	2.123	1.169
3.400+05	1.32992-06	3.18545-01	1.42075+12	1.06144+12	8.67848+01	1.70020+02	2.123	1.169
2.000+06	1.93278-07	5.16364-02	1.84055+12	1.43979+12	3.66962+01	1.51992+03	2.483	1.145
2.000+06	1.93278-07	5.16364-02	1.84055+12	1.43979+12	2.01503+01	4.79722+01	2.483	1.145
1.300+07	2.57391-08	7.63756-03	2.30014+12	1.85501+12	5.34715+00	5.79822+02	2.869	1.129
1.300+07	2.57391-08	7.63756-03	2.30014+12	1.85501+12	3.54262+00	1.07161+01	2.869	1.129
1.000+08	3.13315-09	9.76551-04	2.56450+12	2.09694+12	9.50221-01	2.68806+02	3.064	1.122
1.000+08	3.13315-09	9.76551-04	2.56450+12	2.09694+12	7.82824-01	1.68710+00	3.064	1.122
8.500+08	3.28480-10	1.11811-04	3.16936+12	2.65875+12	3.38825-01	1.39137+02	3.438	1.107
8.500+08	3.28480-10	1.11811-04	3.16936+12	2.65875+12	3.22065-01	2.88899-01	3.438	1.107
8.000+09	3.09192-11	1.15745-05	3.89383+12	3.33227+12	2.24893-01	2.89580+01	3.881	1.096
8.000+09	3.09192-11	1.15745-05	3.89383+12	3.33227+12	2.22271-01	4.22995-02	3.881	1.096
8.500+10	2.83212-12	1.08339-06	4.06873+12	3.49469+12	2.02859-01	3.04934+00	3.987	1.094
8.500+10	2.83212-12	1.08339-06	4.06873+12	3.49469+12	2.02700-01	4.24632-03	3.987	1.094

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 3.400

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	8.80375-02	2.05368+04	7.50852+11	4.00920+11	5.04212+04	7.14595+04	1.013	1.311
2.000+01	8.80375-02	2.05368+04	7.50852+11	4.00920+11	2.39552+04	4.53778+04	1.013	1.311
1.000+02	1.41656-02	3.70844+03	9.59499+11	5.66786+11	3.99607+04	4.59329+04	1.259	1.273
1.000+02	1.41656-02	3.70844+03	9.59499+11	5.66786+11	1.40148+04	2.02949+04	1.259	1.273
5.000+02	2.28903-03	6.78627+02	1.22852+12	7.83767+11	2.72607+04	3.11585+04	1.558	1.241
5.000+02	2.28903-03	6.78627+02	1.22852+12	7.83767+11	7.46462+03	9.84075+03	1.558	1.241
2.500+03	3.64378-04	1.24897+02	1.56193+12	1.04775+12	1.34673+04	2.18512+04	1.957	1.219
2.500+03	3.64378-04	1.24897+02	1.56193+12	1.04775+12	3.27683+03	4.34995+03	1.957	1.219
1.250+04	6.02632-05	2.35176+01	1.98669+12	1.40128+12	4.41353+03	1.46037+04	2.367	1.196
1.250+04	6.02632-05	2.35176+01	1.98669+12	1.40128+12	1.14337+03	1.68546+03	2.367	1.196
6.250+04	1.02219-05	4.49132+00	2.48961+12	1.83050+12	1.05236+03	8.59353+03	2.791	1.176
6.250+04	1.02219-05	4.49132+00	2.48961+12	1.83050+12	3.20028+02	5.62899+02	2.791	1.176
3.400+05	1.66772-06	8.01120-01	2.98397+12	2.26337+12	1.89588+02	4.96587+03	3.145	1.161
3.400+05	1.66772-06	8.01120-01	2.98397+12	2.26337+12	8.05054+01	1.53326+02	3.145	1.161
2.000+06	2.48734-07	1.32159-01	3.69227+12	2.89523+12	3.13777+01	2.24108+03	3.584	1.144
2.000+06	2.48734-07	1.32159-01	3.69227+12	2.89523+12	1.76730+01	3.92806+01	3.584	1.144
1.300+07	3.51520-08	1.99712-02	4.21767+12	3.36541+12	4.30883+00	5.20837+02	3.902	1.135
1.300+07	3.51520-08	1.99712-02	4.21767+12	3.36541+12	3.02395+00	7.62705+00	3.902	1.135
1.000+08	4.47333-09	2.58508-03	4.35671+12	3.49182+12	7.36356-01	7.42929+01	3.986	1.133
1.000+08	4.47333-09	2.58508-03	4.35671+12	3.49182+12	6.32668-01	1.05211+00	3.986	1.133
8.500+08	5.24648-10	3.03939-04	4.38012+12	3.51108+12	2.86584-01	8.87567+00	3.998	1.132
8.500+08	5.24648-10	3.03939-04	4.38012+12	3.51108+12	2.77395-01	1.25122-01	3.998	1.132
8.000+09	5.57230-11	3.22911-05	4.38296+12	3.51367+12	2.12639-01	9.45607-01	4.000	1.132
8.000+09	5.57230-11	3.22911-05	4.38296+12	3.51367+12	2.11893-01	1.33231-02	4.000	1.132
8.500+10	5.24430-12	3.03914-06	4.38336+12	3.51404+12	2.00697-01	8.90513-02	4.000	1.132
8.500+10	5.24430-12	3.03914-06	4.38336+12	3.51404+12	2.00670-01	1.25461-03	4.000	1.132

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 5.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.02103-01	4.45021+04	1.27803+12	6.24206+11	3.51923+04	6.95939+04	1.557	1.341
2.000+01	1.02103-01	4.45021+04	1.27803+12	6.24206+11	1.97196+04	4.17840+04	1.557	1.341
1.000+02	1.81621-02	8.51549+03	1.61911+12	9.15778+11	2.97671+04	4.26386+04	1.751	1.290
1.000+02	1.81621-02	8.51549+03	1.61911+12	9.15778+11	1.24317+04	1.69914+04	1.751	1.290
5.000+02	2.90408-03	1.57895+03	2.18377+12	1.36816+12	2.25867+04	3.07644+04	2.190	1.249
5.000+02	2.90408-03	1.57895+03	2.18377+12	1.36816+12	6.28790+03	7.84374+03	2.190	1.249
2.500+03	4.66222-04	2.96259+02	2.85152+12	1.89829+12	1.15297+04	2.23953+04	2.728	1.223
2.500+03	4.66222-04	2.96259+02	2.85152+12	1.89829+12	2.59786+03	3.35076+03	2.728	1.223
1.250+04	7.82344-05	5.66934+01	3.57923+12	2.49217+12	3.55628+03	1.40150+04	3.252	1.202
1.250+04	7.82344-05	5.66934+01	3.57923+12	2.49217+12	9.20201+02	1.27449+03	3.252	1.202
6.250+04	1.37596-05	1.10170+01	4.27228+12	3.07119+12	7.15720+02	5.81786+03	3.698	1.187
6.250+04	1.37596-05	1.10170+01	4.27228+12	3.07119+12	2.52900+02	3.97819+02	3.698	1.187
3.400+05	2.38260-06	2.00017+00	4.64695+12	3.38963+12	1.06219+02	1.44795+03	3.925	1.181
3.400+05	2.38260-06	2.00017+00	4.64695+12	3.38963+12	5.23641+01	9.06447+01	3.925	1.181
2.000+06	3.98862-07	3.38976-01	4.75869+12	3.48382+12	1.51712+01	2.69719+02	3.986	1.179
2.000+06	3.98862-07	3.38976-01	4.75869+12	3.48382+12	9.53297+00	1.65628+01	3.986	1.179
1.300+07	6.11838-08	5.21196-02	4.78417+12	3.50632+12	2.22735+00	4.26477+01	3.998	1.178
1.300+07	6.11838-08	5.21196-02	4.78417+12	3.50632+12	1.74854+00	2.60932+00	3.998	1.178
1.000+08	7.95010-09	6.77490-03	4.79029+12	3.51195+12	4.83530-01	5.60103+00	4.000	1.178
1.000+08	7.95010-09	6.77490-03	4.79029+12	3.51195+12	4.48536-01	3.42084-01	4.000	1.178
8.500+08	9.35243-10	7.97036-04	4.79196+12	3.51355+12	2.44056-01	6.67758-01	4.000	1.178
8.500+08	9.35243-10	7.97036-04	4.79196+12	3.51355+12	2.40285-01	4.03642-02	4.000	1.178
8.000+09	9.93653-11	8.46843-05	4.79327+12	3.51481+12	2.04507-01	7.79487-02	4.000	1.178
8.000+09	9.93653-11	8.46843-05	4.79327+12	3.51481+12	2.04331-01	4.29440-03	4.000	1.178
8.500+10	9.34847-12	7.96968-06	4.80244+12	3.52360+12	1.99367-01	1.43497-02	4.002	1.178
8.500+10	9.34847-12	7.96968-06	4.80244+12	3.52360+12	1.99363-01	4.05741-04	4.002	1.178

TEMPERATURE = 7.000

SILICON 9/2/61 - GENERAL ATOMIC

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.500+03	6.22979-04	6.51424+02	4.26827+12	2.69968+12	4.95326+03	1.26923+04	3.382	1.245
2.500+03	6.22979-04	6.51424+02	4.26827+12	2.69968+12	1.85938+03	2.30837+03	3.382	1.245
1.250+04	1.11799-04	1.27231+02	4.88885+12	3.18170+12	1.22899+03	4.56126+03	3.769	1.233
1.250+04	1.11799-04	1.27231+02	4.88885+12	3.18170+12	5.61288+02	7.16722+02	3.769	1.233
6.250+04	2.13855-05	2.52137+01	5.16325+12	3.39462+12	2.58732+02	1.18955+03	3.941	1.228
6.250+04	2.13855-05	2.52137+01	5.16325+12	3.39462+12	1.37426+02	1.78708+02	3.941	1.228
3.400+05	3.88457-06	4.62376+00	5.25828+12	3.47274+12	4.31259+01	2.43964+02	3.988	1.226
3.400+05	3.88457-06	4.62376+00	5.25828+12	3.47274+12	2.76597+01	3.56816+01	3.988	1.226
2.000+06	6.58676-07	7.85634-01	5.29117+12	3.50194+12	6.91940+00	4.58512+01	3.998	1.225
2.000+06	6.58676-07	7.85634-01	5.29117+12	3.50194+12	5.07576+00	6.32495+00	3.998	1.225
1.300+07	1.01214-07	1.20838-01	5.31961+12	3.52866+12	1.19809+00	1.00229+01	4.003	1.224
1.300+07	1.01214-07	1.20838-01	5.31961+12	3.52866+12	1.00153+00	9.93934-01	4.003	1.224
1.000+08	1.30817-08	1.56908-02	5.46233+12	3.66305+12	3.35760-01	4.16768+00	4.027	1.220
1.000+08	1.30817-08	1.56908-02	5.46233+12	3.66305+12	3.23034-01	1.36695-01	4.027	1.220
8.500+08	1.47972-09	1.83182-03	6.43857+12	4.58153+12	2.20982-01	2.90249+00	4.188	1.192
8.500+08	1.47972-09	1.83182-03	6.43857+12	4.58153+12	2.19236-01	2.16797-02	4.188	1.192
8.000+09	1.40471-10	1.90634-04	9.45867+12	7.42288+12	2.03163-01	1.20446+00	4.687	1.143
8.000+09	1.40471-10	1.90634-04	9.45867+12	7.42288+12	2.02609-01	4.14125-03	4.687	1.143
8.500+10	1.24316-11	1.77537-05	1.12898+13	9.14749+12	1.99304-01	3.06055-01	4.985	1.126
8.500+10	1.24316-11	1.77537-05	1.12898+13	9.14749+12	1.99282-01	4.99585-04	4.985	1.126

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TEPPERATURE = 10.000

SILICON 9/2/61 - GENERAL ATOMIC

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	1.73639-01	2.12488+05	2.82017+12	9.84459+11	6.37921+03	3.99865+04	2.590	1.434
2.000+01	1.73639-01	2.12488+05	2.82017+12	9.84459+11	5.23182+03	2.45274+04	2.590	1.434
1.000+02	3.12101-02	4.12985+04	3.73912+12	1.75413+12	4.37265+03	2.11764+04	2.882	1.354
1.000+02	3.12101-02	4.12985+04	3.73912+12	1.75413+12	3.43448+03	9.31593+03	2.882	1.354
5.000+02	5.34395-03	7.95355+02	4.77120+12	2.53857+12	2.15784+03	1.02594+04	3.366	1.312
5.000+02	5.34395-03	7.95355+02	4.77120+12	2.53857+12	1.61353+03	3.46477+03	3.366	1.312
2.500+03	9.71758-04	1.55764+03	5.46024+12	3.05579+12	7.70766+02	3.63534+03	3.702	1.294
2.500+03	9.71758-04	1.55764+03	5.46024+12	3.05579+12	5.71627+02	1.11716+03	3.702	1.294
1.250+04	1.84639-04	3.08216+02	5.84875+12	3.34466+12	2.01739+02	1.21242+03	3.897	1.285
1.250+04	1.84639-04	3.08216+02	5.84875+12	3.34466+12	1.53929+02	2.93760+02	3.897	1.265
6.250+04	3.59937-05	6.13247+01	6.11910+12	3.56330+12	5.05916+01	4.57769+02	3.998	1.278
6.250+04	3.59937-05	6.13247+01	6.11910+12	3.56330+12	3.92074+01	7.05360+01	3.998	1.278
3.400+05	6.44417-06	1.12142+01	6.71524+12	4.10477+12	1.38121+01	2.55983+02	4.105	1.259
3.400+05	6.44417-06	1.12142+01	6.71524+12	4.10477+12	1.02473+01	1.62351+01	4.105	1.259
2.000+06	1.01836-06	1.88011+00	8.64101+12	5.87152+12	5.64665+00	1.57775+02	4.416	1.214
2.000+06	1.01836-06	1.88011+00	8.64101+12	5.87152+12	2.94123+00	4.36900+00	4.416	1.214
1.300+07	1.42701-07	2.84486-01	1.13565+13	8.36594+12	9.12544-01	6.60231+01	4.848	1.176
1.300+07	1.42701-07	2.84486-01	1.13565+13	8.36594+12	7.95774-01	1.05063+02	4.848	1.176
1.000+08	1.74131-08	3.65952-02	1.35544+13	1.04018+13	3.22976-01	3.21619+01	5.165	1.155
1.000+08	1.74131-08	3.65952-02	1.35544+13	1.04018+13	3.10523-01	1.81104-01	5.165	1.155
8.500+08	1.86359-09	4.24225-03	1.74387+13	1.40239+13	2.22296-01	1.39844+01	5.678	1.131
8.500+08	1.86359-09	4.24225-03	1.74387+13	1.40239+13	2.20166-01	3.26479-02	5.678	1.131
8.000+09	1.85448-10	4.46458-04	2.05109+13	1.68995+13	2.02176-01	5.29425+00	6.062	1.117
8.000+09	1.85448-10	4.46458-04	2.05109+13	1.68995+13	2.02081-01	4.53618-03	6.062	1.117
8.500+10	1.60924-11	4.15554-05	2.51276+13	2.12540+13	1.99299-01	2.26370+00	6.575	1.103
8.500+10	1.60924-11	4.15554-05	2.51276+13	2.12540+13	1.99292-01	6.12609-04	6.575	1.103

TEMPERATURE = 15.000

SILICON 9/2/61 - GENERAL ATOMIC

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	2.61212-01	5.56002+05	4.26312+12	1.07010+12	3.07390+03	2.27900+04	3.163	1.499
2.000+01	2.61212-01	5.56002+05	4.26312+12	1.07010+12	1.84703+03	1.47802+04	3.163	1.499
1.000+02	4.96080-02	1.09853+05	5.42693+12	2.10508+12	1.54960+03	1.09569+04	3.331	1.408
1.000+02	4.96080-02	1.09853+05	5.42693+12	2.10508+12	9.42139+01	4.98129+03	3.331	1.408
5.000+02	8.84982-03	2.14226+04	6.80447+12	3.17322+12	6.90602+02	6.43122+03	3.754	1.356
5.000+02	8.84982-03	2.14226+04	6.80447+12	3.17322+12	4.19996+02	1.75279+03	3.754	1.356
2.500+03	1.62159-03	4.20865+03	8.43268+12	4.53955+12	2.93672+02	3.96879+03	4.076	1.308
2.500+03	1.62159-03	4.20865+03	8.43268+12	4.53955+12	1.78350+02	6.04504+02	4.076	1.308
1.250+04	2.92994-04	8.25714+02	1.10079+13	6.78036+12	1.22622+02	2.54748+03	4.511	1.256
1.250+04	2.92994-04	8.25714+02	1.10079+13	6.78036+12	7.65432+01	2.17292+02	4.511	1.256
6.250+04	5.31580-05	1.62361+02	1.39091+13	9.32736+12	4.50485+01	1.51244+03	4.973	1.220
6.250+04	5.31580-05	1.62361+02	1.39091+13	9.32736+12	3.04206+01	7.06143+01	4.973	1.220
3.400+05	9.91225-06	2.94063+01	1.74283+13	1.24797+13	1.34207+01	8.88540+02	5.453	1.189
3.400+05	9.91225-06	2.94063+01	1.74283+13	1.24797+13	9.75991+00	2.03759+01	5.453	1.189
2.000+06	1.38629-06	4.93321+00	2.15379+13	1.61997+13	3.37385+00	4.71858+02	5.959	1.165
2.000+06	1.38629-06	4.93321+00	2.15379+13	1.61997+13	2.57731+00	5.12159+00	5.959	1.165
1.300+07	1.96098-07	7.50171-01	2.62716+13	2.05330+13	8.14225-01	2.50762+02	6.481	1.146
1.300+07	1.96098-07	7.50171-01	2.62716+13	2.05330+13	7.05087-01	1.14085+00	6.481	1.146
1.000+08	2.34684-08	9.64872-02	3.17409+13	2.55734+13	3.11697-01	1.18660+02	7.040	1.130
1.000+08	2.34684-08	9.64872-02	3.17409+13	2.55734+13	2.96541-01	2.68366-01	7.040	1.130
8.500+08	2.54475-09	1.12409-02	3.82420+13	3.16157+13	2.19631-01	5.58748+01	7.639	1.116
8.500+08	2.54475-09	1.12409-02	3.82420+13	3.16157+13	2.17778-01	3.45921-02	7.639	1.116
8.000+09	2.51961-10	1.18492-03	4.48179+13	3.77632+13	2.02214-01	2.51410+01	8.197	1.105
8.000+09	2.51961-10	1.18492-03	4.48179+13	3.77632+13	2.01917-01	4.85898-03	8.197	1.105
8.500+10	2.19751-11	1.10633-04	5.31789+13	4.56267+13	1.99270-01	1.07775+01	8.846	1.095
8.500+10	2.19751-11	1.10633-04	5.31789+13	4.56267+13	1.99253-01	6.21167-04	8.846	1.095

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 22.500

GAMMA	RHO(GM/CM3)	P(BARS)	ENE(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	4.01307-01	1.47190+06	7.78544+12	2.28346+12	4.00833+03	2.16674+04	3.782	1.471
2.000+01	4.01307-01	1.47190+06	7.78544+12	2.28346+12	1.59310+03	1.00151+04	3.782	1.471
1.000+02	7.44241-02	2.89902+05	1.06439+13	4.80062+12	1.94705+03	1.39893+04	4.079	1.366
1.000+02	7.44241-02	2.89902+05	1.06439+13	4.80062+12	7.79407+02	3.82123+03	4.079	1.366
5.000+02	1.29931-02	5.65295+04	1.46223+13	8.09582+12	1.05179+03	1.01008+04	4.672	1.298
5.000+02	1.29931-02	5.65295+04	1.46223+13	8.09582+12	4.50188+02	1.60418+03	4.672	1.298
2.500+03	2.29360-03	1.10719+04	1.92784+13	1.20370+13	4.46210+02	7.02711+03	5.294	1.250
2.500+03	2.29360-03	1.10719+04	1.92784+13	1.20370+13	2.14771+02	6.25975+02	5.294	1.250
1.250+04	4.09213-04	2.17642+03	2.45936+13	1.66153+13	1.55109+02	4.71687+03	5.934	1.216
1.250+04	4.09213-04	2.17642+03	2.45936+13	1.66153+13	8.72263+01	2.22834+02	5.934	1.216
6.250+04	7.37725-05	4.29094+02	3.06498+13	2.19246+13	4.83410+01	3.06483+03	6.583	1.190
6.250+04	7.37725-05	4.29094+02	3.06498+13	2.19246+13	2.88929+01	7.22934+01	6.583	1.190
3.400+05	1.22932-05	7.79050+01	3.75704+13	2.80640+13	1.28319+01	1.92266+03	7.262	1.169
3.400+05	1.22932-05	7.79050+01	3.75704+13	2.80640+13	8.66456+00	2.05743+01	7.262	1.169
2.000+06	1.90999-06	1.31059+01	4.55051+13	3.52118+13	2.78709+00	1.13707+03	7.946	1.151
2.000+06	1.90999-06	1.31059+01	4.55051+13	3.52118+13	2.12985+00	5.12480+00	7.946	1.151
1.300+07	2.69979-07	1.99799+00	5.45915+13	4.34901+13	6.80285-01	6.50461+02	8.649	1.136
1.300+07	2.69979-07	1.99799+00	5.45915+13	4.34901+13	6.05912-01	1.11858+00	8.649	1.136
1.000+08	3.23157-08	2.57605-01	6.51774+13	5.32193+13	2.91295-01	3.52072+02	9.393	1.122
1.000+08	3.23157-08	2.57605-01	6.51774+13	5.32193+13	2.80274-01	2.02315-01	9.393	1.122
8.500+08	3.51850-09	3.00891-02	7.69243+13	6.40960+13	2.16706-01	1.79684+02	10.149	1.111
8.500+08	3.51850-09	3.00891-02	7.69243+13	6.40960+13	2.14795-01	3.22124-02	10.149	1.111
8.000+09	3.47950-10	3.17711-03	8.96532+13	7.59559+13	2.01706-01	8.14131+01	10.905	1.102
8.000+09	3.47950-10	3.17711-03	8.96532+13	7.59559+13	2.01494-01	4.51703-03	10.905	1.102
8.500+10	3.07701-11	2.97505-04	1.02339+14	8.78355+13	1.99194-01	2.55781+01	11.606	1.094
8.500+10	3.07701-11	2.97505-04	1.02339+14	8.78355+13	1.99177-01	5.39442-04	11.606	1.094

SILICON 9/2/61-GENERAL ATOMIC

TEMPERATURE = 34.000

GAMMA	RHO(GM/CM3)	P(BARS)	ENG(ERGS/GM)	EION(ERGS/GM)	KROS(CM2/GM)	KPLK(CM2/GM)	ZBAR	EGAM
2.000+01	5.96701-01	3.95919+06	1.61613+13	6.20797+12	9.28862+03	2.43276+04	4.725	1.411
2.000+01	5.96701-01	3.95919+06	1.61613+13	6.20797+12	2.82819+03	8.51967+03	4.725	1.411
1.000+02	1.06385-01	7.76823+05	2.25332+13	1.15795+13	4.29947+03	1.73965+04	5.300	1.324
1.000+02	1.06385-01	7.76823+05	2.25332+13	1.15795+13	1.26442+03	3.53861+03	5.300	1.324
5.000+02	1.84277-02	1.52062+05	3.07996+13	1.84211+13	1.60737+03	1.30722+04	6.120	1.268
5.000+02	1.84277-02	1.52062+05	3.07996+13	1.84211+13	5.33493+02	1.47931+03	6.120	1.268
2.500+03	3.23969-03	2.98957+04	3.99131+13	2.60704+13	5.64218+02	9.70992+03	6.962	1.231
2.500+03	3.23969-03	2.98957+04	3.99131+13	2.60704+13	2.12489+02	5.76233+02	6.962	1.231
1.250+04	5.76119-04	5.89590+03	5.01903+13	3.48366+13	1.73903+02	6.99643+03	7.830	1.204
1.250+04	5.76119-04	5.89590+03	5.01903+13	3.48366+13	7.52268+01	2.03369+02	7.830	1.204
6.250+04	1.03906-04	1.16606+03	6.15251+13	4.46906+13	4.88956+01	4.83450+03	8.682	1.182
6.250+04	1.03906-04	1.16606+03	6.15251+13	4.46906+13	2.45638+01	6.51128+01	8.682	1.182
3.400+05	1.73447-05	2.12315+02	7.44267+13	5.60642+13	1.10661+01	3.12948+03	9.561	1.164
3.400+05	1.73447-05	2.12315+02	7.44267+13	5.60642+13	6.77763+00	1.80325+01	9.561	1.164
2.000+06	2.70554-06	3.58118+01	8.82932+13	6.84373+13	2.26775+00	1.82411+03	10.420	1.150
2.000+06	2.70554-06	3.58118+01	8.82932+13	6.84373+13	1.68446+00	4.38233+00	10.420	1.150
1.300+07	3.86920-07	5.47553+00	1.02340+14	8.11108+13	5.63377-01	8.37338+02	11.210	1.138
1.300+07	3.86920-07	5.47553+00	1.02340+14	8.11108+13	4.98252-01	9.01596-01	11.210	1.138
1.000+08	4.77923-08	7.08912-01	1.13412+14	9.11608+13	2.60797-01	2.06988+02	11.798	1.131
1.000+08	4.77923-08	7.08912-01	1.13412+14	9.11608+13	2.53680-01	1.42334-01	11.798	1.131
8.500+08	5.54078-09	8.33066-02	1.16750+14	9.41955+13	2.08428-01	2.82886+01	11.972	1.129
8.500+08	5.54078-09	8.33066-02	1.16750+14	9.41955+13	2.07337-01	1.76749-02	11.972	1.129
8.000+09	5.87493-10	8.84992-03	1.17230+14	9.46329+13	1.99822-01	3.06842+00	11.997	1.128
8.000+09	5.87493-10	8.84992-03	1.17230+14	9.46329+13	1.99800-01	1.89340-03	11.997	1.128
8.500+10	5.52809-11	8.32919-04	1.17285+14	9.46831+13	1.98938-01	2.89519-01	12.000	1.128
8.500+10	5.52809-11	8.32919-04	1.17285+14	9.46831+13	1.98937-01	1.78408-04	12.000	1.128

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